

**United States Steel Corporation
Minntac Seepage Collection Study
2011 Geotechnical Investigation Report**

Prepared by: _____ December 12, 2011
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Date

Approvals

Hatch

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Date

United States Steel Corporation [Client Name, if required]

Approved by: _____
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1. Introduction

United State Steel Corporation (US Steel) has commissioned Hatch to complete a seepage collection study for the west tailings basin at the Minntac facility. As part of the study, Hatch recommended a geotechnical investigation to be completed to gain better understanding of the subsurface condition within the project limit. The geotechnical investigation was conducted in October of 2011. This report documents the geotechnical information obtained from this investigation.

2. Scope of Work

The geotechnical investigation was conducted in accordance with the following document:

- Hatch, September 2011, "US Steel - Minntac Operation - Seepage Collection Study - Geotechnical Investigation Specification", Document No. H339306-0000-15-123-0001.

This geotechnical investigation included the following:

- Planning of the geotechnical investigation;
- Supervision of the field investigation;
- Preparation of the geotechnical investigation report

3. Previous Investigations

The following reports contain results of previous geotechnical investigations that have been conducted on the eastern side of the tailings basin:

- STS, November 2007, "Subsurface Exploration and Seepage Evaluation – Minntac Tailings Basin – Mountain Iron, Minnesota – U.S. Steel Corporation", Project No. 200703384
- AECOM, December 2009, "United States Steel Corporation - Minnesota Ore Operations – Minntac Tailing Basin Surface Seepage Collection System - Design Report", Project No. 60096104

Although these investigations were conducted on the eastern side nonetheless the information was deemed useful and was considered as part of this study.

4. Site Geology

Minntac is located in Mountain Iron, Minnesota. The tailings basin perimeter dam extends along the northern, western and eastern sides over a length of approximately 9.1 miles with the southern perimeter of the basin against existing high ground. Figure 1 shows the extend of the project area. The basin covers approximately 8,400 acres.

From existing geological report on the bedrock geology, it can be summarized that much of the tailings basin is underlain by pink feldspar granite, which forms a tight, impervious bedrock floor under the overburden. The northwest corner of the basin is underlain by the Ely Greenstone Formation, which is a dense, blackish, dark green meta-volcanic rock. The bedrock is overlain by fluvial and glacial deposits.

The tailings basin situated within the Dark River watershed.

5. Investigative Procedure

The fieldwork was conducted between October 3-8, 2011. Braun Intertec of Hibbing, MN was contracted to complete the drilling and laboratory testing component of the geotechnical investigation under the direction and supervision of Hatch. Description of field and laboratory test results is provided in the following report:

- Braun Intertec, November 2011, "Geotechnical Survey – West Side Seep Collection US Steel Minntac Tailings Basin", Project No. HB-11-06109

The investigative method included both field investigation and laboratory testing and consisted of the following:

- Drilling of boreholes
- Soil sampling, Standard Penetration Testing (SPT)
- Installation of standpipe piezometers
- Laboratory testing

These investigative methods are discussed under the following headings.

5.1 Boreholes

All boreholes were drilled by Braun Intertec. Seven (7) boreholes were drilled. Figure 1 shows the location of boreholes. A full time Hatch geotechnical engineer was present throughout drilling and was responsible for documenting the depths drilled for each drill 'run', selecting sample depths, documenting the standard penetration test blow counts, visualizing and hand texturing of SPT samples, monitoring piezometer installation and measuring water levels after piezometers were installed.

The boreholes were drilled with a CME 55 power auger drill rig. Hollow-stem augers were used to advance the soil borings with Standard Penetration Tests (SPT), ASTM D 1586, performed at select intervals. The rig was equipped with an automatic hammer. The blow counts required to advance the sampler were recorded and are shown on the borehole logs.

Mud drilling was used in several boreholes to advance into water-bearing stratum and to prevent soil back-up.

Rock coring was performed in several boreholes to prove the existence of bedrock at the refusal depth.

Table 1 shows a summary of the boreholes. Figure 1 shows the location of the boreholes. The borehole logs, which also contain the soil test results, are provided in Appendix B. An explanation of the terms and symbols used in the logs is provided in Appendix A.

Table 1. Summary of Borehole Locations and Elevations

Borehole	Depth	Elevation (ft)	Coordinates ^{1.}	
			Easting	Northing
BH1	41.5	892.0	31704.877	-14324.940
BH2	22.5	901.3	25251.321	-14605.909
BH4	31.5	861.5	28747.827	-15239.427
BH5	46.0	896.3	31704.877	-14324.94
BH6	14.5	930.8	20804.673	-16094.316
BH7	31.5	889.6	16962.879	-16226.653
BH9	61.5	845.7	13034.38	-16355.38

1. Minntac Coordinates

Boreholes BH3 and BH8 were not drilled due to unforeseen circumstances encountered at the site, such as insufficient drilling equipment and excessive tailings material.

5.2 Soil Sampling

SPT samples were undertaken in the boreholes. Specific depths and descriptions can be found on the individual borehole logs. Following the field work, all samples were taken to Braun Intertec's geotechnical laboratory for further testing.

5.3 Standpipe Piezometers

Standpipe piezometers were installed at boreholes BH1 and BH7 at the completion of drilling to allow for future monitoring of the groundwater levels.

5.4 Laboratory Testing

The following laboratory tests have been performed on select samples:

- Moisture content determination (ASTM D-2216)
- Liquid and plastic limits (ASTM D-4318)
- Particle size analysis (ASTM D-421 and D-422)
- Hydrometer (ASTM D-422)

6. Subsurface Condition

In general, the subsurface conditions within the project limits consists of tailings over a layer of clay, underlain by fine sand and gravel (alluvium) and silty sand with gravel and clay (glacial till) which overlies the bedrock. Boulders were frequently encountered within the alluvium and glacial till units.

Bedrock is comprised of medium to coarse grained pink granite. The bedrock is slightly weathered near the soil/bedrock interface. Bedrock was encountered at approximately 16.5 ft in one borehole located in the northern section of the project limits (BH2). However, bedrock was not encountered in other boreholes that were generally extended to 60 feet. In places the bedrock is expected to occur at depths in excess of 60 feet from the existing ground surface.

6.1 Topsoil

Borehole BH2 encountered 2 feet of topsoil at the ground surface. This layer extends to El. 899.3ft.

6.2 Tailings

All boreholes, except for BH2, encountered medium to coarse tailings material at the ground surface. This material generally extends to 5.5 to 15 ft (to 55 ft in BH9) below the existing ground surface or Elevation 925.3 to 790.7 ft.

Grain-size distribution of a tailings sample was analysed and yielded 10% gravel, 87% sand and 3% silt. The grain-size distribution is presented in Figure 2.

6.3 Clay

Boreholes BH1, BH2 and BH5 encountered a clay deposit at 2 to 11 ft below the ground surface (El. 899.3-881.0 ft) underlying either tailings or topsoil. This deposit extends to 12.5 to 19 ft below the existing ground surface (El. 888.3-877.3 ft). This deposit consists of silts and clays with some sand and gravel.

Grain-size analyses were performed in the laboratory on two selected samples. Figure 3 shows the result of these tests. The distribution obtained is as follows:

Gravel: 0 – 2 %

Sand: 23 – 26 %

Silt: 53 – 65 %

Clay: 10 – 21 %

The Atterberg Limits of representative samples are shown in Figure 4 and are summarized below:

Liquid Limit: 30 – 35 %

Plastic Limit: 17 – 19 %

Plasticity Index: 12 – 17

These results indicate a clayey material of low to medium plasticity. According to the Unified Soil Classification System these materials are classified as "lean clay with sand".

Standard Penetration tests (SPT) performed within this cohesive deposit yielded N-values between 7 and 17 blows/1.5ft which indicates this deposit is firm to very stiff.

6.4 Alluvial Sand

An alluvial sandy deposit was encountered under the clay deposit in Boreholes BH1, BH2, BH4 and BH5 and under tailings in Borehole BH7. This deposit comprises of sand and gravel with some silts and clay. This deposit was encountered at El. 888.3 to 851.5 ft (10 to 19 ft below existing ground surface) and extends to El. 885.2 to 830.0 ft (16.1 to 46ft below existing ground surface).

The grain-size distributions obtained from three samples from this granular (i.e. non-cohesive) deposit are shown in Figure 5 and are summarized as follows:

Gravel: 1 – 10 %

Sand: 54 – 90 %

Silt: 6 – 29 %

Clay: 4 – 13 %

According to the Unified Soil Classification System these materials are classified as "silty sand".

Standard Penetration tests (SPT) performed within this layer resulted N-values ranging between 7 and in excess of 100 blows/1.5ft, indicating the deposit is loose to very dense.

6.5 Glacial Till

A glacial till deposit was encountered in BH5 and BH9 at 31 (El. 865.3ft) and 55 ft (El. 790.7ft) below the ground surface, respectively. In Borehole BH5, this deposit was contacted in between an alluvial deposit while it is overlain by tailings in BH9. This deposit consists of heterogeneous mixture of gravel, sand, silt and clay with sand and gravel being the main constituents.

Grain-size analysis was performed on two samples from this deposit yielded the following distributions (shown in Figure 6):

Gravel: 31 – 43 %

Sand: 41 – 49 %

Silt: 14 – 31 %

Clay: 2 - 5%

According to the Unified Soil Classification System these materials are classified as "silty sand with gravel".

N-values yielded from the Standard Penetration tests (SPT) performed within this deposit are between 24 and in excess of 50 blows/1ft, indicating this deposit is compact to very stiff.

6.6 Bedrock

Borehole BH2 encountered bedrock at 16.1ft underlying alluvial sand and gravel. The bedrock comprises of pink and black medium to fine grained granite. The rock quality designation (RQD) value is 60% which indicate the rock is fair in quality.

Unconfined compression test was performed on a rock core sample in BH2 yielding an unconfined compressive strength of 36,330psi which indicates the rock is very strong.

6.7 Representative Stratigraphic Sections

Based on the information obtained during this investigation, two (2) subsurface profiles have been chosen to depict the stratigraphy throughout the length of the western side. Figure 7 shows the corresponding areas for these sections. These representative stratigraphic sections, Sections A and B, are presented in Figure 8.

Stratigraphic representative sections were produced in order to provide practical information for the seepage collection conceptual options study.

7. Groundwater Condition

Two piezometers were installed in Boreholes BH1 and BH7. The water levels observed in these piezometers are presented in Table 2.

Table 2. Summary of Piezometer Readings

Borehole	Ground Elevation (ft)	Observed Water Level / Elevation (ft)	Date Measured
BH1	891.0	10.6 / 880.4	October 14, 2011
		10.4 / 880.6	November 4, 2011
BH7	889.6	19 .0 / 870.6	October 14, 2011
		19.2 / 870.4	November 4, 2011

It appears that the groundwater table is about 10-15ft from the ground surface at locations at a distance from Dark River. In areas close to Dark River the groundwater table dips towards the river (both from the north and from the south).

8. Summary

The geotechnical investigation at the western side included the drilling of seven (7) boreholes. Laboratory tests were performed on the collected soil samples. These tests included soil particle size, hydrometer, moisture content and Atterberg limits.

Field investigation and laboratory test results were used to produce representative stratigraphic sections. These sections were produced to be utilized in the seepage collection conceptual options study.

Two piezometers were installed during the field investigation. It appears that the groundwater table is at about 10-15ft depth.

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FIGURES



UNITED STATES STEEL CORPORATION
MINNTAC OPERATIONS
SEEPAGE COLLECTION STUDY

**PROJECT AREA &
BOREHOLE LOCATION PLAN**

DATE: 12/12/2011
SCALE: NOT TO SCALE

FIGURE No. 1

REPORT: H339306-0000-15-124-0001| REVISION A

Client: United States Steel Corporation

Grain Size Distribution

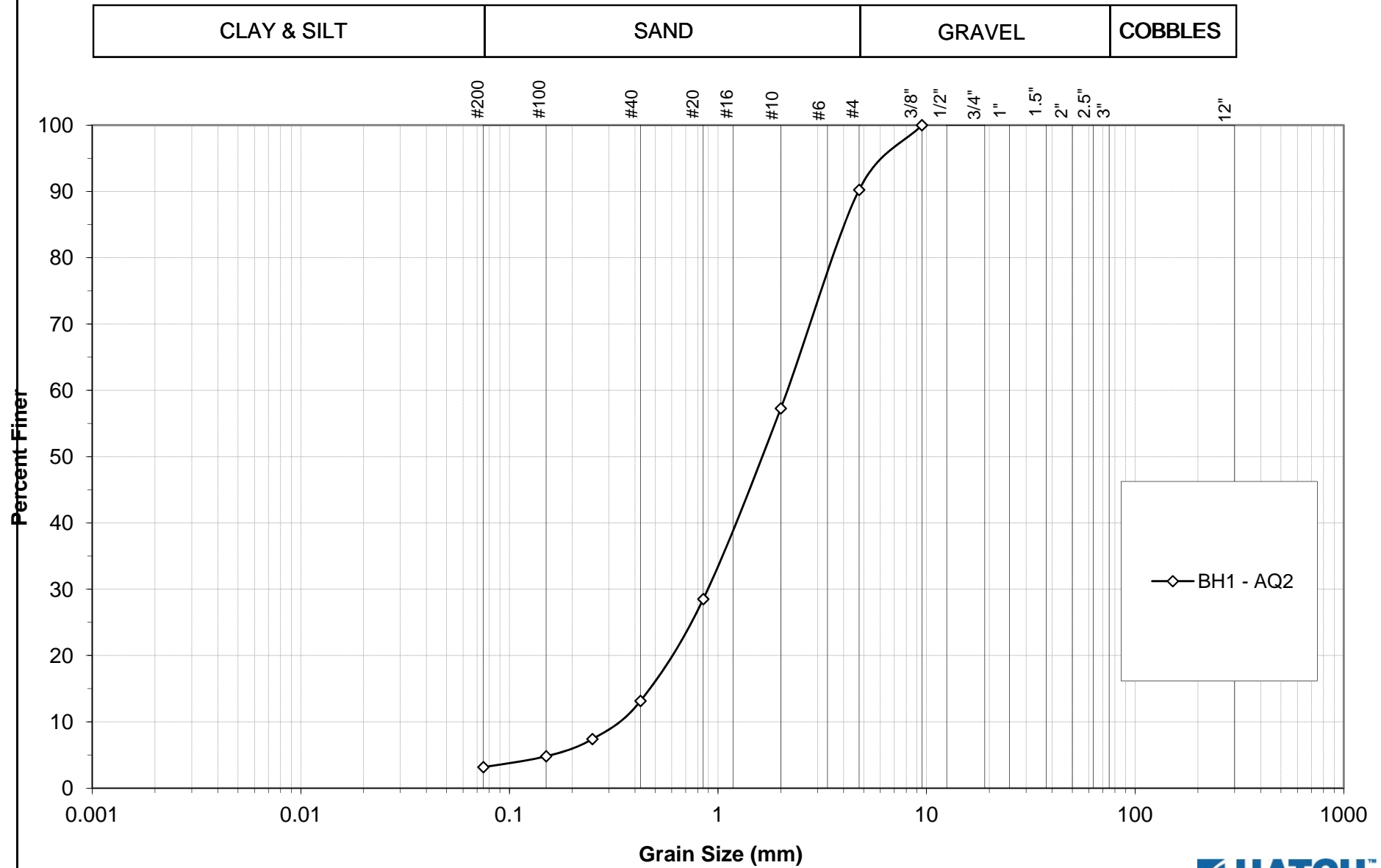


Figure 2 – Tailings

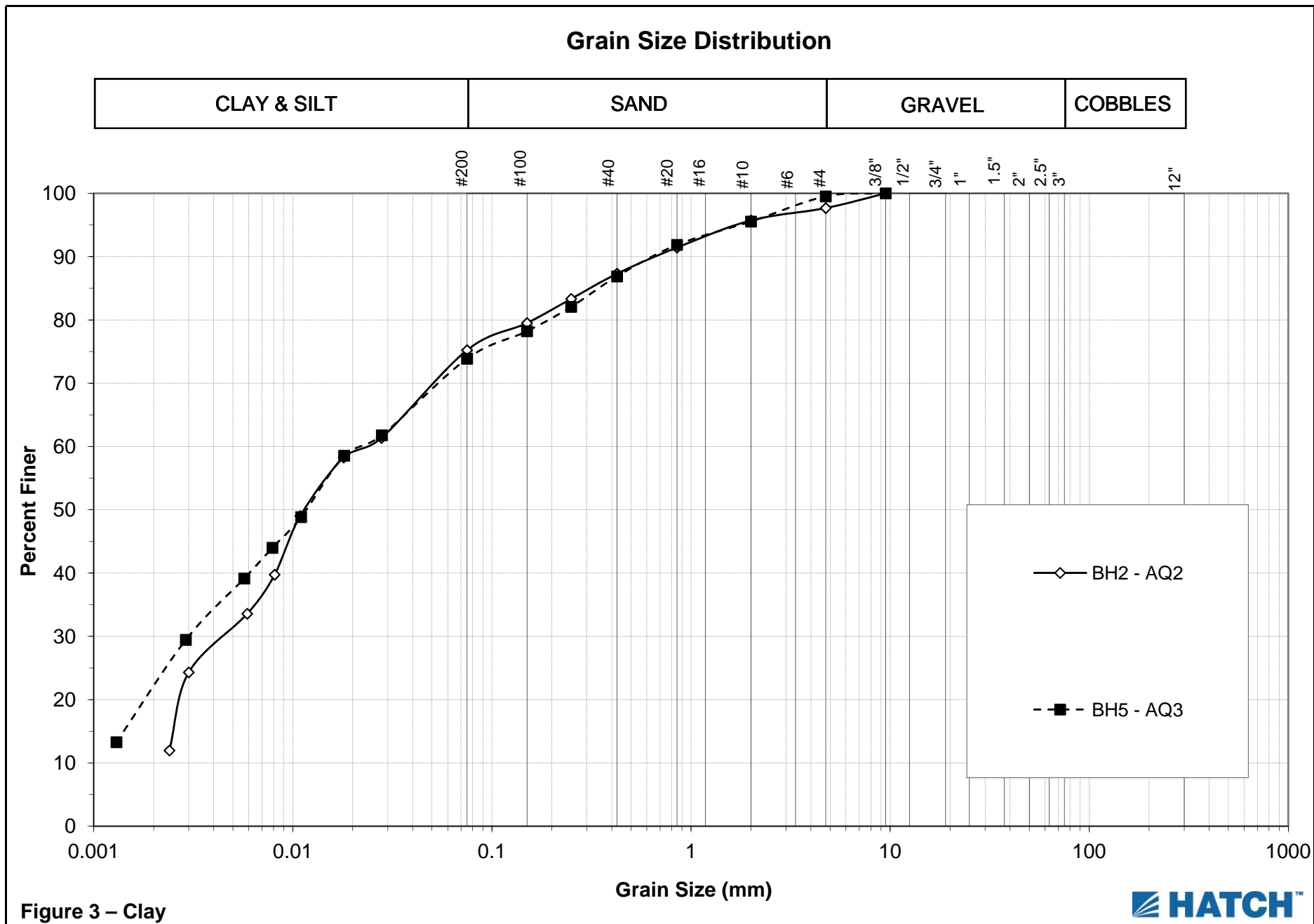
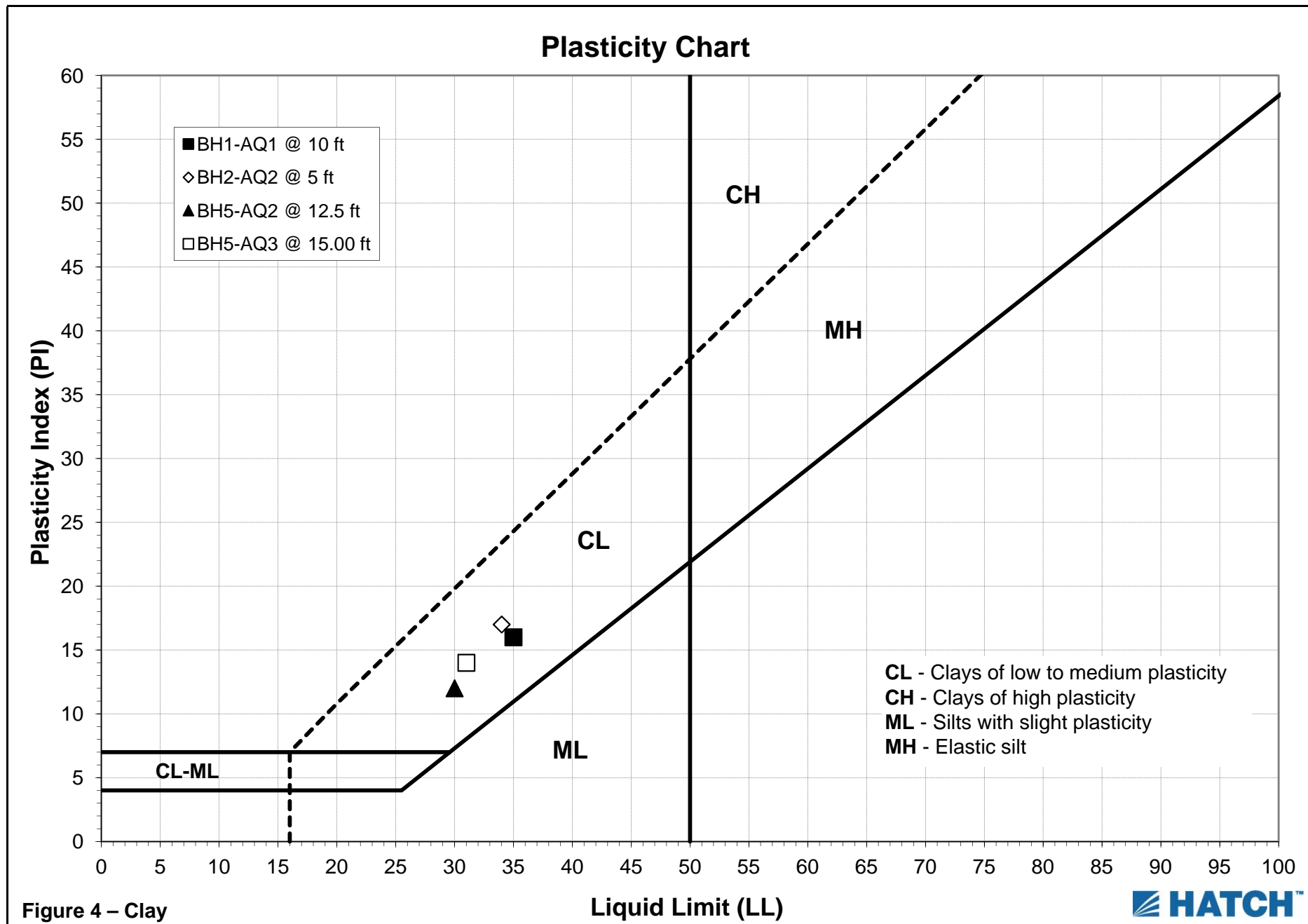


Figure 3 – Clay



Client: United States Steel Corporation

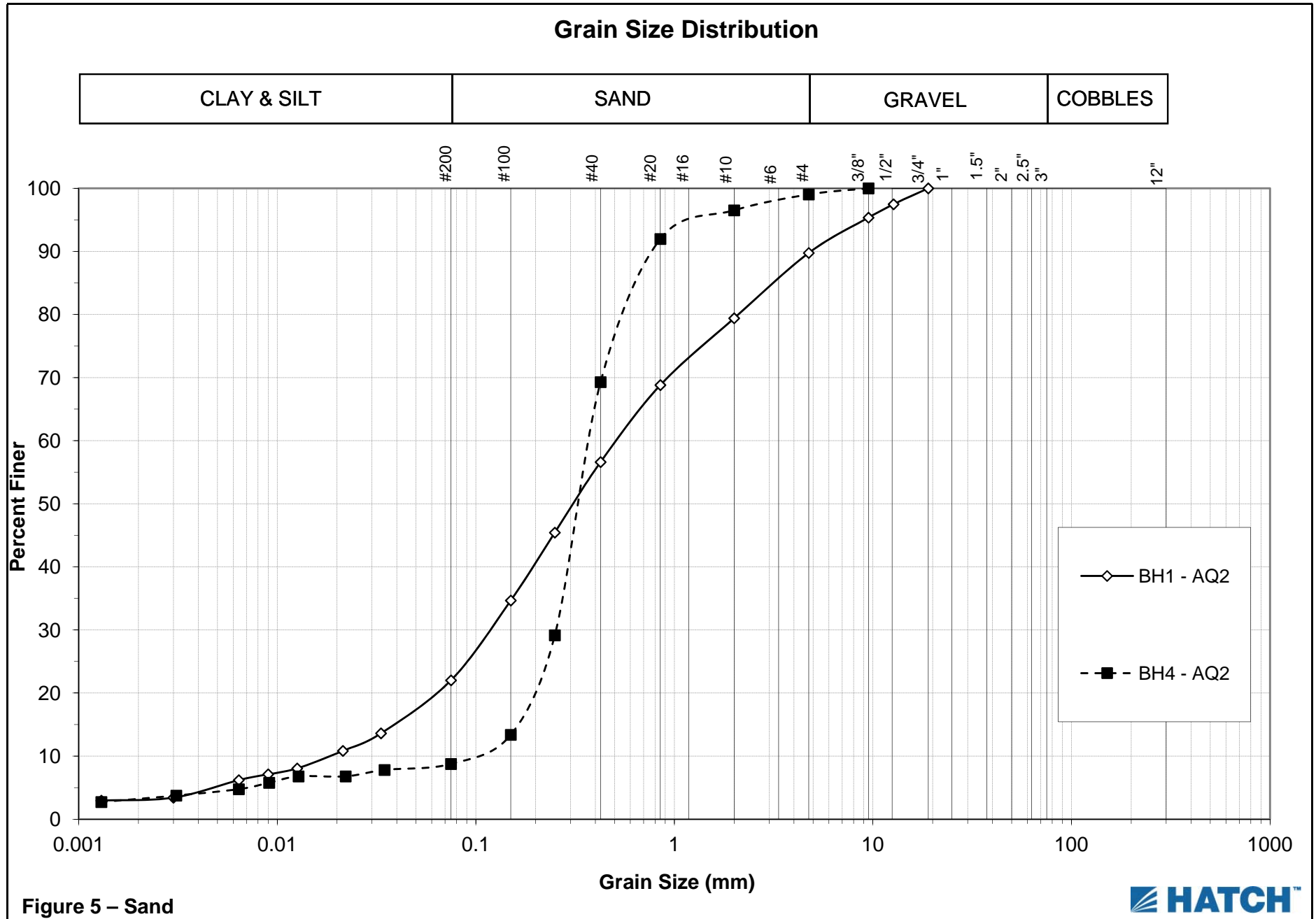


Figure 5 – Sand

Client: United States Steel Corporation

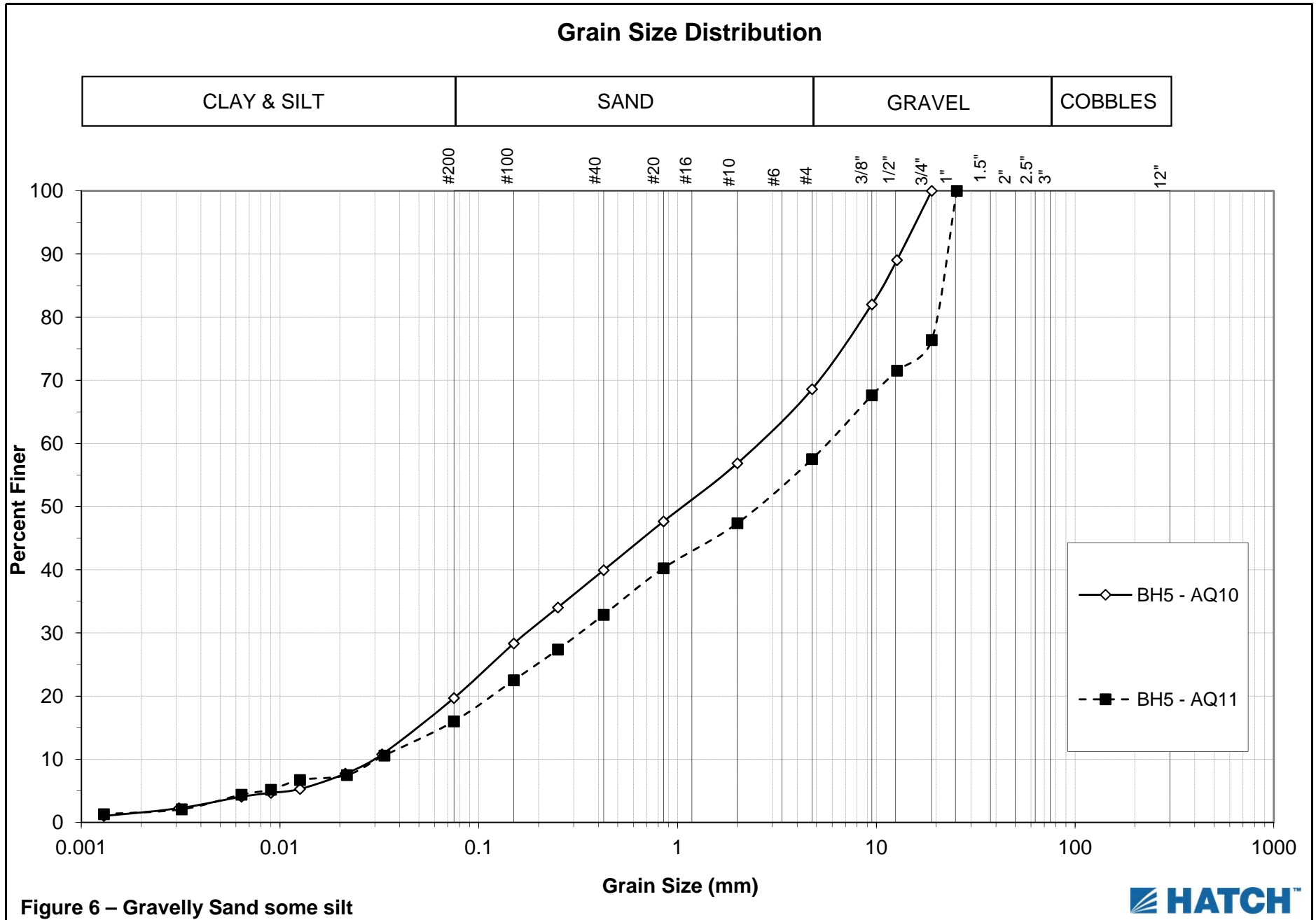


Figure 6 – Gravelly Sand some silt



UNITED STATES STEEL CORPORATION
MINNTAC OPERATIONS
SEEPAGE COLLECTION STUDY

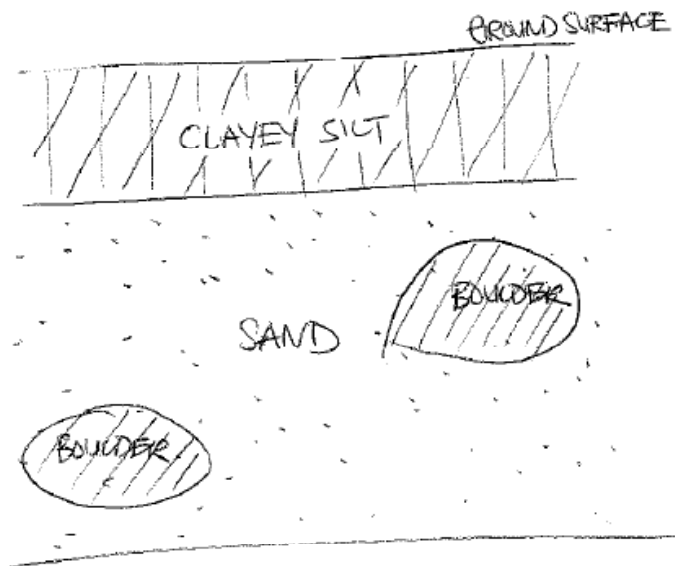
AREAS OF REPRESENTATIVE
SECTIONS

DATE: 12/12/2011
SCALE: NOT TO SCALE

FIGURE No. 7

REPORT: H339306-0000-15-124-0001| REVISION A

SECTION A - TYPICAL GROUND CONDITIONS



SECTION B - TYPICAL GROUND CONDITIONS

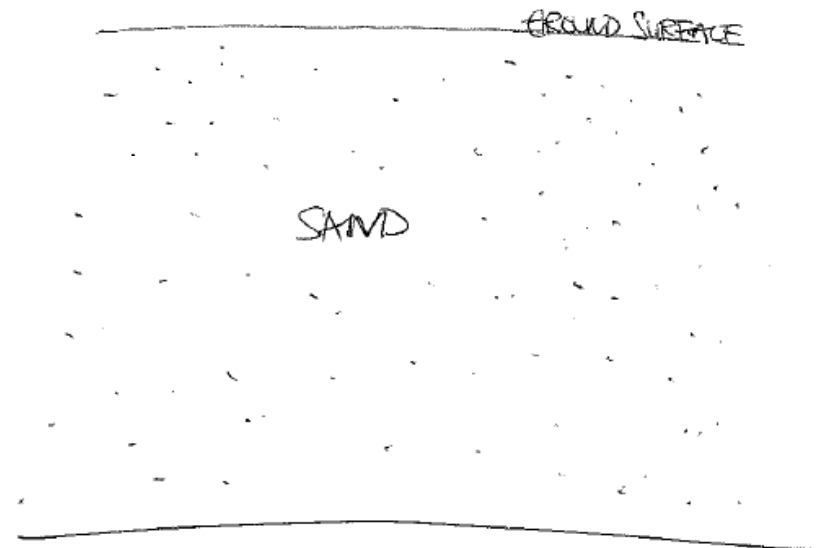


Figure 8 – Representative Stratigraphic Sections

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APPENDIX A

List of Abbreviations and Terms Used in the Borehole Reports

General

Elevations

Elevations are referenced to datum indicated.

Depth

All depths are given in meters (feet) measured from the ground surface unless otherwise noted.

Sample Recovery

Indicates the length retained in millimeters (inches) in a split spoon sampler or percentage recovery of sample retained in the core barrel sampler.

Sample Number

Samples are numbered consecutively in the order in which they were obtained or attempted in the borehole.

Sample Type

The first letter describes the sampling method and the second, the shipping container.

Sampling Method

A – Split Tube	E – Auger
B – Thin Wall Tube	F – Wash
C – Piston Sampler	G – Shovel Grab Sample
D – Core Barrel	K – Slotted Sampler

Shipping Container

O – Tube	U – Not Recovered
P – Water Content Tin	X – Plastic & PVC Sleeve (Sonic)
Q – Jar	Y – Core Box
S – Plastic Bag	Z – Discarded

Abbreviations

N/A – Not applicable
N/E – Not encountered
N/O – Not observed

Soil

Soil Description, Label and Symbol

Soil description under the “Description” column conforms generally, but not rigorously, to the Unified Soils Classification System. For a given soil unit, defined by depth boundaries, the descriptive text constitutes the definitive soil unit description and takes precedence over both the brief label and the symbol used to graphically represent the soil unit.

Grain Size

Clay	<0.002 mm
Silt	0.002 – 0.075 mm
Sand	0.075 – 4.75 mm
Fine	0.075 – 0.42 mm
Medium	0.42 – 2.00 mm
Course	2.00 – 4.75 mm
Gravel	4.75 – 75 mm
Fine	4.75 – 19.00 mm
Coarse	19.00 – 75.00mm
Cobbles	75 – 300 mm
Boulder	>300 mm

Relative Quantities

Term	Example	(%)
Trace	Trace sand	1 – 10
Some	Some sand	10 – 20
With (adjective)	With Sand (Sandy)	20 – 35
And	And sand	>35
Noun	Sand	>50

Standard Penetration Test (SPT)

The test is carried out in accordance with ASTM D-1586 and the ‘N’ value corresponds to the sum of the number of blows required by a 63.5-kg (140-lb) hammer, dropped 760 mm (30 in.), to drive a 50-mm (2-in.) diameter split tube sampler the second and third 150 mm (6 in.) of penetration.

Density (Granular Soils)

	N(SPT)
Very loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very dense	>50

Consistency (Cohesive Soils)

	N(SPT)
Very soft	<2
Soft	2 – 4
Firm	4 – 8
Stiff	8 – 15
Very stiff	15 – 30
Hard	>30

Plasticity/Compressibility

		Liquid Limit (%)
Low plasticity clays	Low compressibility silts	<30
Medium plasticity clays	Medium compressibility silts	30 – 50
High plasticity clays	High compressibility silts	>50

Dilatancy

None	- No visible change, during shaking or squeezing
Slow	- Water appears slowly on surface of specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	- Water appears quickly on the surface of specimen during shaking and disappears quickly upon squeezing.

Sensitivity

Insensitive	<2
Low	2 – 4
Medium	4 – 8
High	8 – 16
Quick	>16

Rock

Core Recovery

Sum of lengths of rock core recovered from a core run, divided by the length of the core run and expressed as a percentage.

RQD (Rock Quality Designation)

Sum of lengths of hard, sound pieces of rock core equal to or greater than 100 mm from a core run, divided by the length of the core run and expressed as a percentage. Measured along centerline of core. Core fractured by drilling is considered intact. RQD normally quoted for N-size core.

RQD (%) Rock Quality

90 - 100	Excellent
75 - 90	Good
50 - 75	Fair
25 - 50	Poor
0 - 25	Very Poor

Grain Size

Term

Grain Size

Very coarse-grained	>60 mm
Coarse-grained	2 mm - 60 mm
Medium-grained	60 µm - 2 mm
Fine-grained	2 µm - 60 µm
Very fine-grained	< 2 µm

Bedding

Term

Bed Thickness

Very thickly bedded	>2 m	>6.50 ft
Thickly bedded	600 mm - 2 m	2.00 - 6.50 ft
Medium bedded	200 mm - 600 mm	0.65 - 2.00 ft
Thinly bedded	60 mm - 200 mm	0.20 - 0.65 ft
Very thinly bedded	20 mm - 60 mm	0.06 - 0.20 ft
Laminated	6 mm - 20 mm	0.02 - 0.06 ft
Thinly laminated	<6 mm	<0.02 ft

Discontinuity Frequency

Expressed as the number of discontinuities per meter or discontinuities per foot. Excludes drill-induced fractures and fragmented zones.

Discontinuity Spacing

Term

Average Spacing

Extremely widely spaced	>6 m	>20.00 ft
Very widely spaced	2 m - 6 m	6.50 - 20.00 ft
Widely spaced	600 mm - 2 m	2.00 - 6.50 ft
Moderately spaced	200 mm - 600 mm	0.65 - 2.00 ft
Closely spaced	60 mm - 200 mm	0.20 - 0.65 ft
Very closely spaced	20 mm - 60 mm	0.06 - 0.20 ft
Extremely closely spaced	<20 mm	<0.06 ft

Note: Excludes drill-induced fractures and fragmented rock.

Broken Zone

Zone of full diameter core of very low RQD which may include some drill-induced fractures.

Fragmented Zone

Zone where core is less than full diameter and RQD = 0.

Strength Term

Description

Unconfined Compressive Strength (MPa) (psi)

Extremely weak rock	Indented by thumbnail	0.25 - 1.0	36 - 145
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	1.0 - 5.0	145 - 725
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5.0 - 25	725 - 3625
Medium strong rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer to fracture it	25 - 50	3625 - 7250
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	50 - 100	7250 - 14500
Very strong rock	Specimen requires many blows of geological hammer to fracture it	100 - 250	14500 - 36250
Extremely strong rock	Specimen can only be chipped with geological hammer	>250	>36250

Weathering Term

Description

Fresh	No Visible sign of rock material weathering
Faintly weathered	Discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

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APPENDIX B
Borehole Reports



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH1**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 2

SITE: Minntac West Tailings Basin

COORDINATES: -15004.392
22583.753

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/5/2011
FINISHED: 10/6/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

DIP DIRECTION:
DIP:

CASING:

ELEVATIONS

DATUM: Lake Superior
PLATFORM: N/A
GROUND: 891.0
END OF HOLE: 849.5

CORE:

DATE: 11/24/2011

See end page for detailed
groundwater measurements

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION
			DEPTH	TYPE/ NUMBER	REC'D (in)	REC'D (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴			
891.0									SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS				GR SA SI CL	
									5	10	15	20	10	20	30 (%)			
0.0		TAILINGS; medium to coarse, brown, dry						1										
								2										
								3										
								4										
								5										
								6										
								7										
								8										
								9										
881.0								10										
10		CLAY; some gravel, low plasticity, brown, stiff, moist	10	AQ-1			6	11	●									
			11.5				8											
							6	12										
878.5								13										
12.5		SAND; medium to coarse, rounded to subangular, brown with mixture of pink and black grains, compact to very dense, moist	12.5	AQ-2			14	14										
			14				10											
							14											
			15	AQ-3			21	15										
			16.5				87	16										
							8											
			17.5	AQ-4			11	17										
			19				18	18										
							15	19										
871.5																		
19.5		GRANITE BOULDER																

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability














BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH1

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 2

ELEV.	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION 20 40 60 80	HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION				
DEPTH (ft)			DEPTH	TYPE/ NUMBER	RECY (in)	RECY (%)	BLOW COUNTS			SHEAR STRENGTH (psi)						WATER CONTENT & ATTERBERG LIMITS			
										UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB VANE POCKET PEN.	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴				10 20 30 (%)			
868.5 22.5		SAND; medium to coarse, rounded to subangular, brown with mixture of pink and black grains, loose to very dense, wet	 20 20.7	AQ-5			23 50/21	21						Spoon wet					
								22											
			 22.5	AQ-6			23 20 29	23											
				24				24											
			 25	AQ-7			10 11 9	25											
				26.5				26											
								27											
			 27.5	AQ-8			5 8 9	28											
				29				29											
			 30	AQ-9			4 6 7	30											
				31.5				31											
								32											
			 32.5	AQ-10			8 5 2	33											
			34				34												
		 35	AQ-11			5 4 3	35												
			36.5				36												
							37												
		 37.5	AQ-12			5 4 5	38												
			39				39												
		 40	AQ-13			50 21 25	40												
			41.5				41												
849.5 41.5			END OF BOREHOLE																

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability

BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH2

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 2

SITE: Minntac West Tailings Basin

COORDINATES: -14605.909
25251.321

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK:

STARTED: 10/7/2011
FINISHED: 10/7/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

DIP DIRECTION:
DIP:

CASING:

ELEVATIONS

DATUM: Lake Superior
PLATFORM: N/A
GROUND: 901.3
END OF HOLE: 878.8

CORE:

DATE: 11/24/2011

See end page for detailed groundwater measurements

[illegible]

SAMPLING METHOD




A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT

W_P W_N W_L

-  Constant Head Test
-  Falling Head Test
-  Lab. Permeability

Project: H/339306



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH2

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 2

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION	
			DEPTH	TYPE/ NUMBER	REC'Y (in)	REC'Y (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴				
									SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS						
									<input type="checkbox"/> UNCONFINED <input checked="" type="checkbox"/> FIELD VANE <input checked="" type="checkbox"/> QUICK TRIAXIAL <input checked="" type="checkbox"/> LAB VANE <input checked="" type="checkbox"/> POCKET PEN.										
									5	10	15	20	10	20	30 (%)				
878.8 22.5								21											
								22											
END OF BOREHOLE																			

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT
W_P W_N W_L

- ☐ Constant Head Test
☒ Falling Head Test
☒ Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH4**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 2

SITE: Minntac West Tailings Basin

COORDINATES: -15239.427
28747.827

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/3/2011
FINISHED: 10/3/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

DIP DIRECTION:
DIP:

CASING:

ELEVATIONS

DATUM: Lake Superior
PLATFORM: N/A
GROUND: 861.5
END OF HOLE: 830.0

CORE:

DATE: 11/24/2011

See end page for detailed
groundwater measurements

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
			DEPTH	TYPE/ NUMBER	REC'D (in)	REC'D (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		GR	SA	SI	CL	
861.5																					
0.0		TAILINGS; medium to coarse, brownish grey, dry	0	EQ-1				1													
			1					2													
								3													
								4													
								5													
								6													
								7													
								8													
								9													
851.5								10													
10		Silty SAND; some clay and cobbles, brownish grey, compact, moist to wet	10	AQ-2			5	11									4	54	27	15	
			11.5				5	12													
			12.5	AQ-3			7	13													
			14				9	14													
847.5								15													
14		SAND; coarse, some silt, rounded to subangular, brown with mixture of pink and black grains, compact to very dense, wet	15	AQ-4			2	16													
			16.5				5	17													
			17.5	AQ-5			8	18													
			19				6	19									1	90	4	4	

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH4

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 2

ELEV.		SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
DEPTH (ft)	DEPTH			TYPE/ NUMBER	RECY (in)	RECY (%)	BLOW COUNTS	SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS			GR	SA		SI	CL			
								20		40	60	80	10 ⁻⁶	10 ⁻⁵						10 ⁻⁴		
										UNCONFINED QUICK TRIAXIAL				FIELD VANE LAB VANE POCKET PEN.								
										5	10	15	20	10	20	30 (%)						
830.0 31.5					20	AQ-6			4	21												
				21.5	5				9													
					22.5	AQ-7			8	23												
					24				8										12			
					25	AQ-8			10	26												
					26.5				30										37			
					27.5	AQ-9			80	28												
					29				36										27			
					30	AQ-10			19	31												
					31.5				17										18			
										END OF BOREHOLE												

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_P W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH5**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 3

SITE: Minntac West Tailings Basin

COORDINATES: -14324.94
31704.877

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/3/2011
FINISHED: 10/5/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

DIP DIRECTION:
DIP:

CASING:

ELEVATIONS

DATUM: Lake Superior
PLATFORM: N/A
GROUND: 896.3
END OF HOLE: 850.3

CORE:

DATE: 11/24/2011

See end page for detailed groundwater measurements

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
			DEPTH	TYPE/ NUMBER	REC'Y (in)	REC'Y (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		GR	SA	SI	CL	
896.3																					
0.0		TAILINGS; medium to coarse, brown, dry	0	EQ-1				1													
			1					2													
								3													
								4													
								5													
								6													
								7													
								8													
								9													
								10													
885.3		CLAY; some coarse sand, low plasticity, grey, stiff to very stiff, moist						11													
								12													
			12.5	AQ-2			5	13													
			14				4	14													
								15													
			15	AQ-3			3	16													
			16.5				5	17													
							7	18													
			17.5	AQ-4			4	19													
							7														
877.3		SAND; coarse, medium to coarse, rounded to	19				9														

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH5**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 3

ELEV.	SYMBOL		DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
DEPTH (ft)				DEPTH	TYPE/ NUMBER	RECY (in)	RECY (%)	BLOW COUNTS		SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS				GR	SA	SI	CL	
										UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB VANE POCKET PEN.	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴								
									5	10	15	20		10	20	30 (%)						
			subangular, brown with mixture of pink and black grains, loose to very dense, wet	20	AQ-5			8													Spoon wet	
				21.5				11														
				22.5	AQ-6			3														
				24				4														
				25	AQ-7			2														
				26.5				3														
				27.5	AQ-8			2														
				29				42														
				30	AQ-9			4														
865.3				31.5				9														
31			Silty Sand TILL; medium to fine, grey, dense, wet	32				13														
				32.5	AQ-10			3														
				34				13													31 49 16 4	
				35	AQ-11			64														
				36.5				27														
				37.5	AQ-12			20														
857.3				39				18														
39			SAND; coarse, medium to coarse, rounded to subangular, brown with mixture of pink and black grains, compact to very dense, wet	40	AQ-13			30														
				41.5				14														
				42.5	AQ-14			77														
				44				23														
				45				10														
								84														

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH5

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 3 OF: 3

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION	
			DEPTH	TYPE/ NUMBER	REC'Y (in)	REC'Y (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴				
									SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS						
									□ UNCONFINED ✕ FIELD VANE ■ QUICK TRIAXIAL ◆ LAB VANE ♦ POCKET PEN.										
									5	10	15	20	10	20	30 (%)				
850.3			X	AQ-15				22											
46			X	AQ-16				46											
END OF BOREHOLE																			

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT
W_p W_N W_L

- ☐ Constant Head Test
☒ Falling Head Test
☒ Lab. Permeability

BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH6

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 1

SITE: Minntac West Tailings Basin

COORDINATES: -16094.316
20804.673

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/4/2011

FINISHED: 10/4/2011

DIP DIRECTION:
DIP:

CASING:

INSPECTOR: W. Chan

LOGGED BY: W. Chan

REVIEWED: A. Touhidi

ELEVATIONS

DATUM: Lake Superior

PLATFORM:	N/A
-----------	-----

GROUND: 930.8

END OF HOLE: 916.3

CORE:

DATE: 11/24/2011

See end page for detailed groundwater measurements

ELEV.	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION						
DEPTH (ft)			DEPTH	TYPE/ NUMBER	RECY (in)	RECY (%)	BLOW COUNTS		SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS				GR	SA	SI	CL							
									UNCONFINED				FIELD VANE									LAB VANE			POCKET PEN.		
930.8			0																								
0.0		TAILINGS; medium to coarse, brown, dry	1	EQ-1				1																			
								2																			
								3																			
								4																			
								5																			
925.3			5				11	5																			
5.5		Silty Sand TILL; medium to fine grain, some gravel and cobbles, grey, compact to very dense, moist	6.5	AQ-2			16	6																			
							18	7																			
								8																			
			7.5	AQ-3			4	8																			
			8.5				17	9																			
							>50	10																			
920.8			10	AQ-4			>50	10																			
10		BOULDER	10					11																			
								12																			
								13																			
917.3			13.5	AQ-5			>50	13																			
13.5		Silty Sand TILL; medium to fine grain, some gravel and cobbles, grey, very dense, moist	13.5					14																			
916.3																											
14.5																											
																	</										

SAMPLING METHOD




A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT

W_P W_N W_L

-  Constant Head Test
-  Falling Head Test
-  Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH7**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 2

SITE: Minntac West Tailings Basin

COORDINATES: -16226.653
16962.879

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/6/2011
FINISHED: 10/6/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

DIP DIRECTION:
DIP:

CASING:

ELEVATIONS

DATUM: Lake Superior
PLATFORM: N/A
GROUND: 889.6
END OF HOLE: 858.1

CORE:

DATE: 11/24/2011

See end page for detailed
groundwater measurements

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
			DEPTH	TYPE/ NUMBER	REC'Y (in)	REC'Y (%)	BLOW COUNTS		20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		GR	SA	SI	CL	
889.6																					
0.0		TAILINGS; medium to coarse, brown, dry to moist	0	EQ-1				1													
			1					2													
								3													
								4													
								5													
								6													
								7													
								8													
								9													
								10													
								11													
								12													
								13													
								14													
874.6								15													
15		SAND; medium to coarse, some gravel and cobbles, rounded to subangular, compact to very dense,, moist to wet	15	AQ-2			3	16													
			16.5				24	17													
							34	18													
			17.5	AQ-3			10	19													
			19				28	20													

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
W_p W_N W_L

Constant Head Test
Falling Head Test
Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH7

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 2

ELEV.		SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION
DEPTH (ft)	DEPTH			TYPE/NUMBER	RECY (in)	RECY (%)	BLOW COUNTS	SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS							
								20		40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	GR			
858.1 31.5																			
END OF BOREHOLE																			

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT
W_P W_N W_L

Constant Head Test
 Falling Head Test
 Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: **BH9**

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 1 OF: 3

SITE: Minntac West Tailings Basin

COORDINATES: -16355.38
13034.38

CONTRACTOR: Braun Intertec
DRILL TYPE: CME 45B
METHOD SOIL: Hollow Stem Augers
ROCK: N/A

STARTED: 10/7/2011
FINISHED: 10/8/2011
INSPECTOR: W. Chan
LOGGED BY: W. Chan
REVIEWED: A. Touhidi

ELEVATIONS


DATUM: Lake Superior
PLATFORM: N/A
GROUND: 845.7
END OF HOLE: 784.2

CASING:

CORE:

DATE: 11/24/2011

See end page for detailed groundwater measurements

ELEV.		SYMBOL	DESCRIPTION	SAMPLE					DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				PIEZOMETER INSTALLATION
DEPTH (ft)				DEPTH	TYPE/ NUMBER	RECY (in)	RECY (%)	BLOW COUNTS		SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS								
										20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴						
845.7																						
0.0				0.5	EQ-1																	
			TAILINGS; medium to coarse grained, brown, moist to wet						1													
									2													
									3													
									4													
						5.5	EQ-2		5													
									6													
									7													
									8													
									9													
									10													
									11													
									12													
									13													
									14													
									15													
									16													
									17													
					18																	
					19																	

SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT
W_p W_N W_L

☐ Constant Head Test
☒ Falling Head Test
☒ Lab. Permeability



BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH9

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 2 OF: 3

ELEV. DEPTH (ft)	SYMBOL	DESCRIPTION	SAMPLE				BLOW COUNTS	DEPTH (ft)	SPT N-VALUES DYNAMIC CONE PENETRATION				HYDRAULIC CONDUCTIVITY (ft/s)			BULK DENSITY (lb/ft ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	PIEZOMETER INSTALLATION	
			DEPTH	TYPE/ NUMBER	RECY (in)	RECY (%)			20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴				
									SHEAR STRENGTH (psi)				WATER CONTENT & ATTERBERG LIMITS						
									□ UNCONFINED ✕ FIELD VANE ■ QUICK TRIAXIAL ◆ LAB VANE ◆ POCKET PEN.										
									5	10	15	20	10	20	30 (%)				
								21											
								22											
								23											
								24											
								25											
								26											
								27											
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SAMPLING METHOD

A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT
W_P W_N W_L

- ☐ Constant Head Test
- ☐ Falling Head Test
- ☐ Lab. Permeability

BOREHOLE REPORT

CLIENT: United State Steel Corporation

HOLE: BH9

PROJECT: Minntac - Seepage Collection System- West Tailings Basin

PAGE: 3 OF: 3

[illegible]

SAMPLING METHOD




A - Split Tube
B - Thin Wall Tube
C - Piston Sample
D - Core Barrel
E - Auger
F - Wash
G - Shovel Grab
K - Slotted

SHIPPING CONTAINER

N - Insert
O - Tube
P - Water Content Tin
Q - Jar
R - Cloth Bag
S - Plastic Bag
U - Wooden Box
Y - Core Box
Z - Discarded

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT

W_P W_N W_L

-  Constant Head Test
-  Falling Head Test
-  Lab. Permeability

DRAFT

APPENDIX C
Geotechnical Survey by Braun Intertec

Geotechnical Survey

West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota

Prepared for

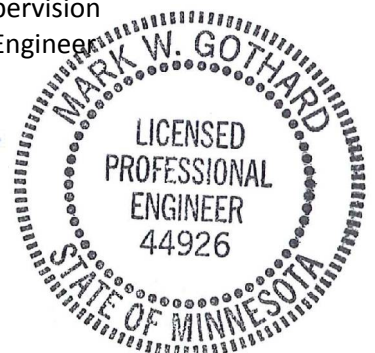
United States Steel Corporation

Professional Certification:

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.



Mark W. Gothard, PE
Principal Engineer
License Number: 44926
November 3, 2011



Project HB-11-06109

Braun Intertec Corporation

November 3, 2011

BIC Project HB-11-06109

Mr. Rob Wilmunen
United States Steel Corporation
PO Box 417
Mountain Iron, MN 55768

Re: Geotechnical Survey
United States Steel – Minnesota Ore Operations
MinnTac West Side Tailings Basin Seep Collection
Mountain Iron, Minnesota
USS Purchase Order Number 01042800

Dear Mr. Wilmunen:

We are pleased to present this Geotechnical Survey Report for the MinnTac West Side Tailings Basin Seep Collection. The purpose of the investigation was to provide subsurface soil profile and groundwater data in support of Hatch's engineering and design efforts for the West Side Tailings Basin Seep Collection that serves United States Steel's MinnTac Mine.

As requested, we are not providing analysis and recommendations as part of our services, only this summary report containing results, procedures and laboratory test results.

Scope of Services

Our scope of services for this project was originally submitted as a Proposal to Mr. Jack Loadman on September 14, 2011. We were subsequently issued USS Purchase Order Number 01042800 dated September 22, 2011, as authorization to proceed. Tasks performed in accordance with our authorized scope of services included:

- Performing a reconnaissance of the site to evaluate equipment access to exploration locations.
- Clearing exploration locations of underground utilities.
- Performing nine penetration test borings to depths ranging between 15 and 35 feet.
- Installing three temporary stand pipe piezometers to obtain groundwater measurements.
- Performing laboratory index tests and strength tests on selected penetration test samples.
- Preparing this report containing exploration logs and results of laboratory tests.

At the time of our field exploration, it was determined access to boring location SB-3 was not possible for our flotation tire-mounted drill rig due to steep terrain. In addition, Hatch decided to eliminate Boring SB-8 and the corresponding piezometer installation from the field exploration.

Locations and Elevations

We completed the soil borings at the general locations indicated on the Proposed Borehole Location Plan (prepared by Hatch and dated September 2, 2011), and adjacent stakes placed in the field by Hatch. The general locations are indicated on the attached boring location sketch.

The ground surface elevations at the boring locations will be provided by Hatch at a future date.

Results

Exploration Logs

Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance tests performed within them, laboratory tests performed on penetration test samples and thin-walled tube samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

Geologic Profile

As revealed by the borings, the subsurface soil profile consisted of existing fill underlain by native alluvial and glacial deposits, with the exception of Boring SB-2 which encountered buried topsoil above the glacial deposits at a depth of 2-1/2 feet.

Existing Fill

The borings initially encountered existing fill soils to depths ranging from about 2-1/2 to 55 feet. The existing fill consisted of coarse taconite tailings (classified as poorly graded sand with silt SP-SM)) that was brown to gray in color and moist to wet. The existing fill also included varying amounts of gravel.

Alluvial Deposits

Below the existing fill in Borings SB-2 and SB-5, the borings encountered alluvial deposits consisting of lean clay (CL) with gravel that was brown in color and moist to wet. The alluvial deposits extended to depths ranging from 12-1/2 to 20 feet.

Glacial Deposits

Below the existing fill and alluvial deposits, the borings encountered glacial deposits that consisted of poorly graded sand with silt (SP-SM) and silty sand (SM) that was brown to gray in color and moist to wet. The glacial deposits also included varying amounts of gravel and cobbles. The glacial deposits were generally encountered to the termination depths of the borings.

All borings were terminated upon refusal of the hollow-stem auger at depths ranging from 5-1/2 to 61 feet. Refusal means the auger could not be advanced further without excessive effort. Refusal can be caused by bedrock, cobbles, boulders and hardpan. Coring below the termination depth in Boring SB-2 confirmed the refusal occurred on granite bedrock. Coring in Boring SB-6 indicated refusal likely occurred on a boulder.

Inferred Geologic Material Properties

The results of our penetration resistance testing are summarized below in Table 1. Comments are provided to qualify the significance of the results. Penetration resistances in the existing fill were not conducted due to blind drill through fill material.

Table 1. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances	Comments
Existing Fill	SP-SM		Variably Compacted
Alluvial Deposits (Cohesive)	CL	9 to 17	Rather Stiff to Very Stiff
Glacial Deposits (Cohesionless)	SM, SP-SM	9 to 83 blows for 1 inch of drive	Loose to Very Dense

Groundwater

Groundwater observations are summarized below in Table 2.

Based on the granular nature of the predominant sand soils encountered in the borings, it is our opinion the groundwater level at these borings was likely below the termination depths of the borings at the time of our field investigation.

Seasonal and annual fluctuations of both perched and hydrostatic groundwater levels should be anticipated. In particular, elevated levels should be expected following spring thaw and heavy rains. Also, in fine grained, perched levels are common following spring thaw and heavy rains.

After the borings were performed, we installed temporary piezometers in two of the borings, SB-1 and SB-7.

Table 2. Groundwater Summary

Location	Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
SB-1	TBD	16.5	TBD
SB-4	TBD	9.0	TBD
SB-5	TBD	18.5	TBD
SB-7	TBD	19.0	TBD
SB-9	TBD	1.0	TBD

Based on the granular nature of the predominant sand soils encountered in the borings, it is our opinion the groundwater level at these borings was likely below the termination depths of the borings at the time of our field investigation.

Seasonal and annual fluctuations of both perched and hydrostatic groundwater levels should be anticipated. In particular, elevated levels should be expected following spring thaw and heavy rains. Also, in fine grained, perched levels are common following spring thaw and heavy rains.

After the borings were completed, we installed temporary stand pipe piezometers in Borings SB-1 and SB-7.

Laboratory Test Results

To assist in classifying and evaluating the engineering properties of the soils and rock, two specific gravity analyses, four Atterberg limits, nine hydrometer analysis, and one unconfined compression test(s) were conducted on samples retrieved during drilling. Results of the tests are indicated at the depths from which the samples were obtained, in the "Tests or Notes" columns of the attached Log of Boring sheets or on individual sheets following the Log of Boring sheets.

Procedures

Drilling and Sampling

The penetration test borings were drilled with a flotation-tire-mounted core and auger drill equipped with hollow-stem auger and mud rotary drilling equipment. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Material Classification and Testing

Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM or AASHTO procedures.

Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

Qualifications

Variations in Subsurface Conditions

Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Remarks

Thank you for making Braun Intertec your consultant for this project. If you have questions about this Report, or if there are other services that we can provide in support of our work to date, please contact Alex Peritz at aperitz@braunintertec.com or Mark Gothard mgothard@braunintertec.com. We can also be reached in our Hibbing office at 800.828.7313.

Sincerely,

BRAUN INTERTEC CORPORATION



Alex Peritz, EIT
Staff Engineer



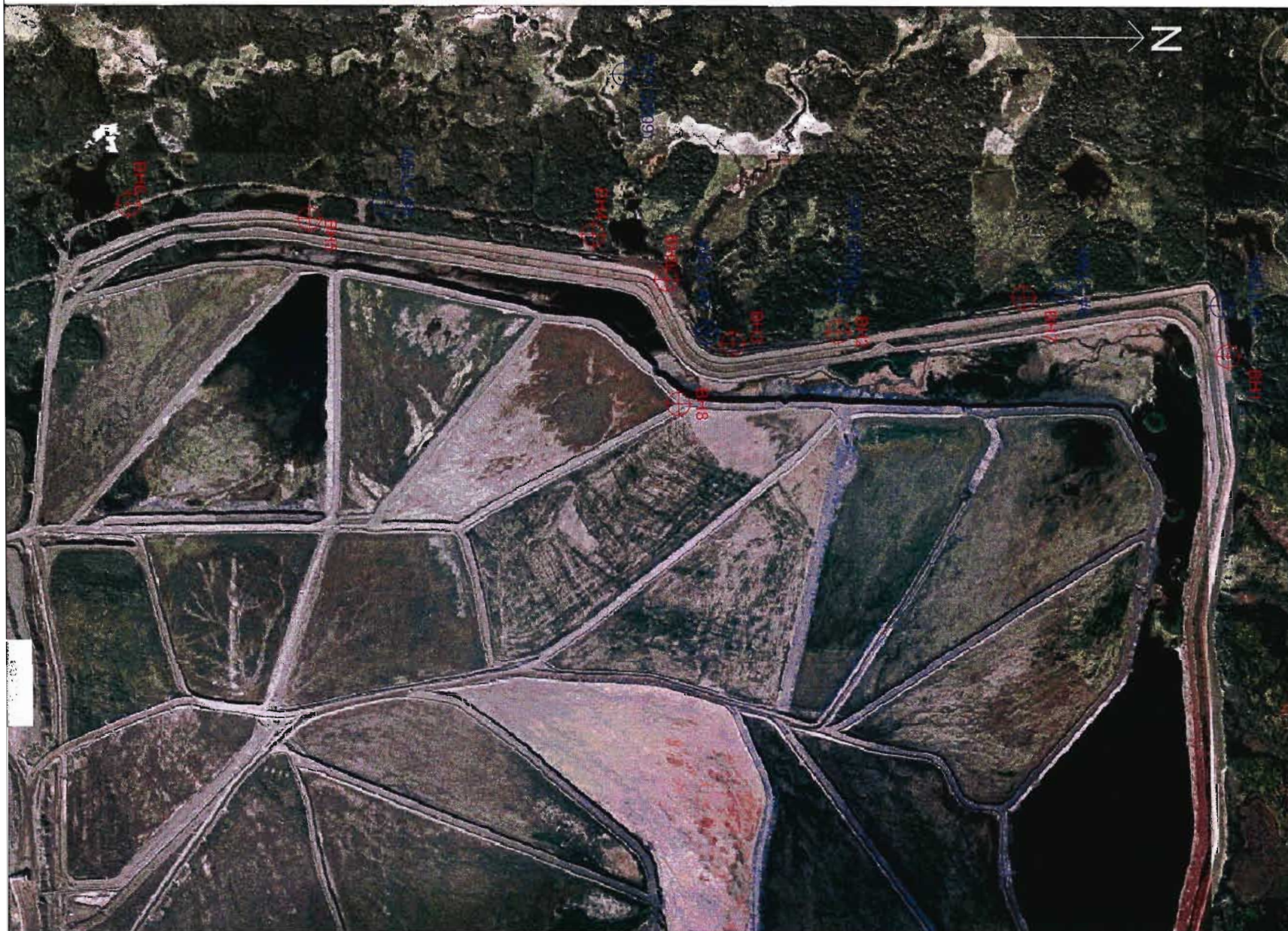
Mark W. Gothard, PE
Principal Engineer

Attachments:

Boring Location Sketch
Log of Boring/Coring Sheets
Descriptive Terminology
Grain Size Accumulation Curve (9)
Atterberg Limits Test Results (1)
Unconfined Compression Test Results (1)

c: Ms. Winnie Chan, Geotechnical Engineer-In-Training
Hatch, Ltd.
Sheridan Science & Technology Park
2800 Speakman Drive
Mississauga, ON
L5K 2R7 Canada

Boring Location Sketch



HATCH™
UNITED STATES STEEL CORPORATION
MINNTAC OPERATIONS
SLEEPPAGE COLLECTION STUDY
PROPOSED BOREHOLE
LOCATION PLAN

DATE: 2 SEPTEMBER 2011
SCALE: NOT TO SCALE
FIGURE No. 1
REPORT: H339306-0000-15-123-0001 | REVISION 0









**Log of Boring/Coring Sheets
and
Descriptive Terminology**

Braun Project HB-11-06109					BORING: SB-1	
Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					LOCATION: See Attached Sketch	
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		
SCALE: 1" = 4'						
Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes
		Blind drill through tailings to 10 feet.				Benchmark: Soil boring locations staked by Hatch. Surface elevations will be provided by Hatch.
10.0	CL	LEAN CLAY, with Sand and a trace of Gravel, brown, moist, stiff. (Alluvium)	14			LL = 35 PL = 19 PI = 16
12.5	SM	SILTY SAND, fine- to medium-grained, with a little Gravel, brown, moist to wet, medium dense to very dense. (Glacial Till)	24		22.0	See attached Grain Size Accumulation Curve An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate. SG = 2.670
19.5		END OF BORING - Refusal at 19.5 feet.	50/2"			
		Water observed at a depth of 14 feet while drilling.				
		Water observed at a depth of 16 1/2 feet immediately after withdrawal of auger.				
		Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:07

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-1A LOCATION: 15' west of SB-1 See Attached Sketch		
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		SCALE: 1" = 4'	
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Well	Tests or Notes	
0.0		Blind drill to 19.5 feet.				Grout Seal; surface to 3'	
19.5	SM	SILTY SAND, fine- to medium-grained, with a little to some Gravel, brown, wet, medium dense to loose to dense. (Glacial Till)				Sand Backfill	
			24			Top of Grout Seal; 25'	
			17			Bottom of Grout Seal; 27' Sand Backfill	
			13			Top of screen; 29' Screen	

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-1A (cont.) LOCATION: 15' west of SB-1 See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		SCALE: 1" = 4'	
Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Well	Tests or Notes	
		SILTY SAND, fine- to medium-grained, with a little to some Gravel, brown, wet, medium dense to loose to dense. (Glacial Till) (continued)	 7			Screen	
			 7				
			 9				
41.0			 46			Bottom of screen; 39'	
		END OF BORING. Water observed at a depth of 14 feet while drilling. Water observed at a depth of 16 1/2 feet immediately after withdrawal of auger. Piezometer installed.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:08

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-2 LOCATION: See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11		SCALE: 1" = 4'	
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes	
0.0							
2.5	TS	TOPSOIL: Silty Sand, fine- to medium-grained, with a trace of roots, brown, moist. (Topsoil)					
12.5	CL	LEAN CLAY, with Sand and a trace of Gravel, brown, moist, very stiff to rather stiff. (Alluvium)	17				
15.0	SP-SM	POORLY GRADED SAND with SILT and GRAVEL, fine- to medium-grained, brown, moist, very dense. (Glacial Till)	50				
		END OF BORING - Refusal at 15 feet. Water not observed immediately after withdrawal of auger. Boring then backfilled.	83/1"				
					75	LL = 34 PL = 17 PI = 17 See attached Grain Size Accumulation Curve	

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:08

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-2A	
				LOCATION: 10' south of SB-2 See Attached Sketch	
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11	SCALE: 1" = 4'
Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
		Blind drill to 15.5 feet.			
15.5		END OF BORING - Refusal at 15.5 feet. Water not observed immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:08

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-2B	
				LOCATION: 10' south of SB-2A See Attached Sketch	
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11	SCALE: 1" = 4'
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0		Blind drill to 13.5 feet.			
13.5		END OF BORING - Refusal at 13.5 feet. Water not observed immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:09

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-2C	
				LOCATION: 10' south of SB-2B See Attached Sketch	
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11	SCALE: 1" = 4'
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0		Blind drill to 13 feet.			
13.0		Boring continued as cored borehole			

LOG OF CORING

LOG OF CORING N:\GINTY\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT (See Descriptive Terminology sheet for explanation of abbreviations)

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota						CORING: SB-2C (cont.)			
						LOCATION: 10' south of SB-2B See Attached Sketch			
						DATE: 10/7/11		SCALE: 1" = 0.5'	
Depth feet	Description of Core	Bit Pressure (psi)	Rate of Advance (min/ft)	Water		Rec. %	RQD %	Remarks	
13.0				Press (psi)	Loss				
13.0	GRANITE, gray/pink/black, slightly weathered, very hard, thick bedded, moderately to slightly fractured.		4 min/ft	30	Yes	50	30		
15.5	END OF CORING.								



NOTES: Rock wedged in core barrel; pulled core barrel and lost hole.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:10

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-4 LOCATION: See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		SCALE: 1" = 4'	
Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes	
		Blind drill through tailings to 9 feet.					
9.0	SM	SILTY SAND, fine- to medium-grained, with a trace of Gravel, brown, moist, medium dense. (Glacial Till)	12		41.7	See attached Grain Size Accumulation Curve	
12.5	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with a trace of Gravel, brown, wet, loose to very dense. (Glacial Till)	19				
			10				
			12		8.7	See attached Grain Size Accumulation Curve	
			13				
			22				
			65				
			63				
			36				
32.0							

(See Descriptive Terminology sheet for explanation of abbreviations)






LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:10

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-4 (cont.)				
LOCATION: See Attached Sketch									
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		SCALE: 1" = 4'			
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes			
32.0		END OF BORING. Water observed at a depth of 12 feet while drilling. Water observed at a depth of 9 feet immediately after withdrawal of auger. Boring then backfilled with bentonite grout.							

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:10

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-5 LOCATION: See Attached Sketch				
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/5/11		SCALE: 1" = 4'			
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes			
0.0		Blind drill through tailings to 10 feet.							
10.0	CL	LEAN CLAY with Sand, fine- to medium-grained, brown, moist to wet, rather stiff to stiff. (Alluvium)	11			LL = 30 PL = 18 PI = 12 74 LL = 31 PL = 17 PI = 14 See attached Grain Size Accumulation Curve * SG = 2.731			
			12						
			15 *	▽					
20.0	SP-SM	POORLY GRADED SAND with SILT and GRAVEL, fine- to coarse-grained, brown, wet, loose to very dense. (Glacial Till)	22						
			10						
			9						
			65						
30.0	SM	SILTY SAND with GRAVEL, fine- to coarse-grained, brown, wet, loose to very dense. (Glacial Till)	22						

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-5 (cont.) LOCATION: See Attached Sketch				
DRILLER: M. Heinzen			METHOD: 3 1/4" HSA, Autohammer		DATE: 10/5/11		SCALE: 1" = 4'		
Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)				BPF	WL	P200 %	Tests or Notes
32.5		SILTY SAND with GRAVEL, fine- to medium-grained, gray to brown, wet, dense to medium dense. (Glacial Till)				 47		19.6	See attached Grain Size Accumulation Curve
						 47		16.0	See attached Grain Size Accumulation Curve
						 38			
						 27			
		Mud rotary drilling techniques used at 45 feet.							
47.0		END OF BORING. Water observed at a depth of 18 1/2 feet while drilling. Boring then backfilled with bentonite grout.							

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-6			
					LOCATION: See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11		SCALE: 1" = 4'		
Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)			BPF	WL	P200 %	Tests or Notes
2.5	SM	Blind drill through tailings to 2.5 feet.			34		35.3	See attached Grain Size Accumulation Curve
5.5		SILTY SAND with GRAVEL, fine-grained, gray, moist, medium dense. (Glacial Till)						
		END OF BORING - Refusal at 5.5 feet. Water not observed immediately after withdrawal of auger. Boring then backfilled.						

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:11

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-6A	
DRILLER: M. Heinzen METHOD: 3 1/4" HSA, Autohammer					LOCATION: 6' north of SB-6 See Attached Sketch	
DATE: 10/6/11			SCALE: 1" = 4'			
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes	
0.0		Blind drill to 5 feet.				
5.0						
8.0	SM	SILTY SAND with GRAVEL, fine-grained, gray, moist, very dense. (Glacial Till)				
		END OF BORING - Refusal at 8 feet. Water not observed immediately after withdrawal of auger. Boring then backfilled.	67/1"			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:11

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-6B	
				LOCATION: 6' north of SB-6A See Attached Sketch	
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/6/11	
SCALE: 1" = 4'					
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0		Blind drill to 9 feet.			
9.0		END OF BORING - Refusal at 9 feet; possible boulder. Rock core from 9 to 14.5 feet; no sample returned. Water not observed immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:11

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-7 LOCATION: See Attached Sketch		
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11		SCALE: 1" = 4'	
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Well	Tests or Notes	
0.0		Blind drill through tailings to 12.5 feet.			[Pattern: Vertical Lines]	Grout Seal; surface to 3'	
12.5	SP-SM	POORLY GRADED SAND with SILT and GRAVEL, fine- to medium-grained, brown, moist to wet, very dense to medium dense. (Glacial Till)			[Pattern: Dotted]	Sand Backfill	
			53		[Pattern: Vertical Lines]	Top of Grout Seal; 15'	
			48		[Pattern: Dotted]	Bottom of Grout Seal; 17'	
					[Pattern: Dotted]	Sand Backfill	
					[Pattern: Dotted]	Top of screen; 19'	
			65		[Pattern: Dotted]		
			24		[Pattern: Dotted]		
			27		[Pattern: Dotted]		
			32		[Pattern: Dotted]		
					[Pattern: Dotted]	Bottom of screen; 29'	
31.0		END OF BORING - Refusal at 31 feet.	16				

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-7 (cont.)			
				LOCATION: See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/7/11		SCALE: 1" = 4'	
Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)			BPF	WL	Well
		Water observed at a depth of 19 feet while drilling. Piezometer installed.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:11

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota					BORING: SB-9		
					LOCATION: See Attached Sketch		
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/8/11		SCALE: 1" = 4'	
Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes	
		Blind drill through tailings to 55 feet.		▽			
					3.2	See attached Grain Size Accumulation Curve	

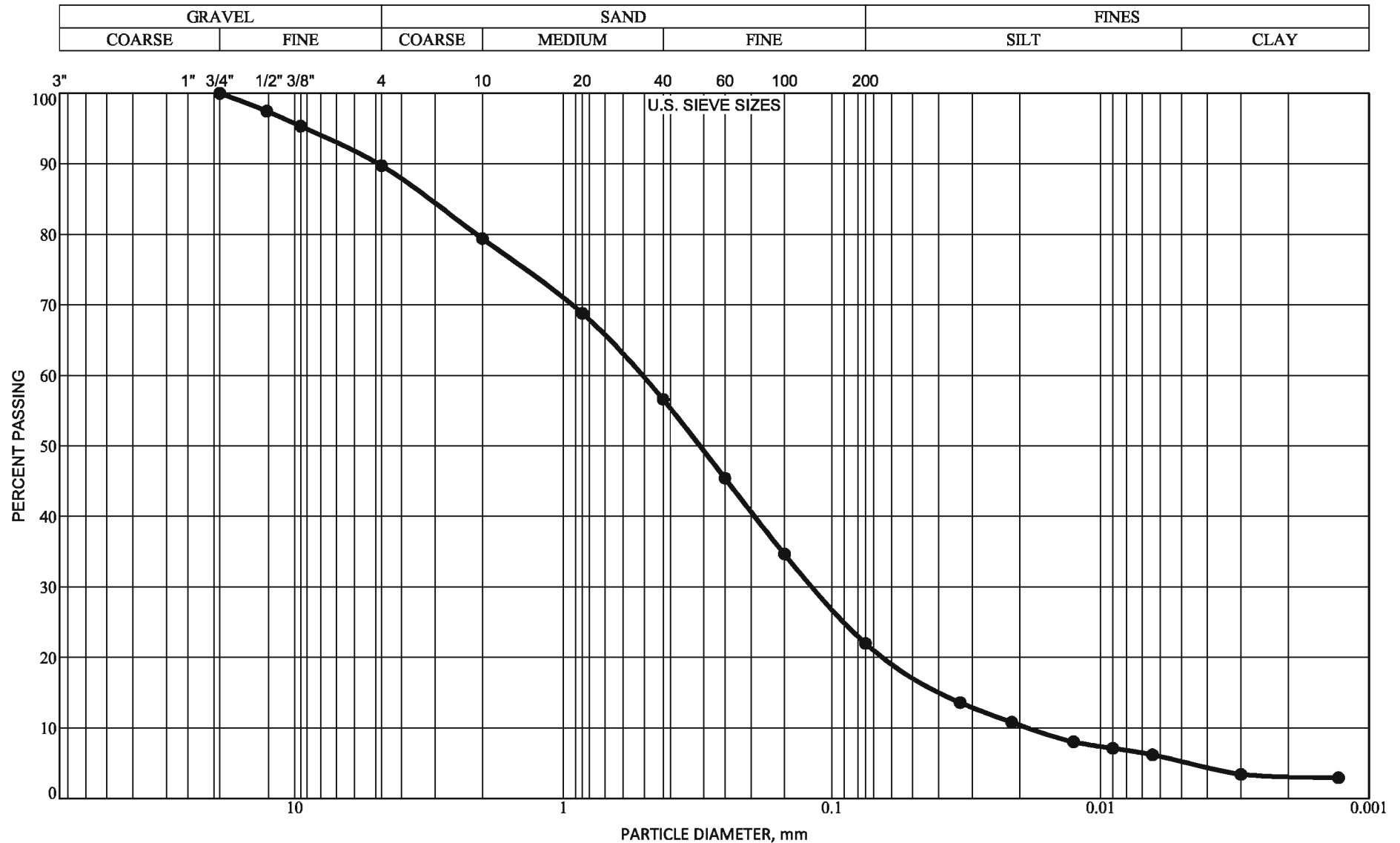
(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\HIBBING\2011\06109.GPJ BRAUN_V8_CURRENT.GDT 11/3/11 11:11

Braun Project HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				BORING: SB-9 (cont.)			
				LOCATION: See Attached Sketch			
DRILLER: M. Heinzen		METHOD: 3 1/4" HSA, Autohammer		DATE: 10/8/11		SCALE: 1" = 4'	
Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	P200 %	Tests or Notes	
32.0		Blind drill through tailings to 55 feet. <i>(continued)</i>					
55.0	SP-SM	POORLY GRADED SAND with SILT and GRAVEL, fine- to medium-grained, brown, wet, dense. (Glacial Till)	41				
			45				
61.0		Fractured rock at 60 feet.	34				
		END OF BORING.					
		Water observed at a depth of 1 foot while drilling.					
		Boring immediately backfilled with bentonite grout.					

Laboratory Test Results

GRAIN SIZE ACCUMULATION CURVE (ASTM)

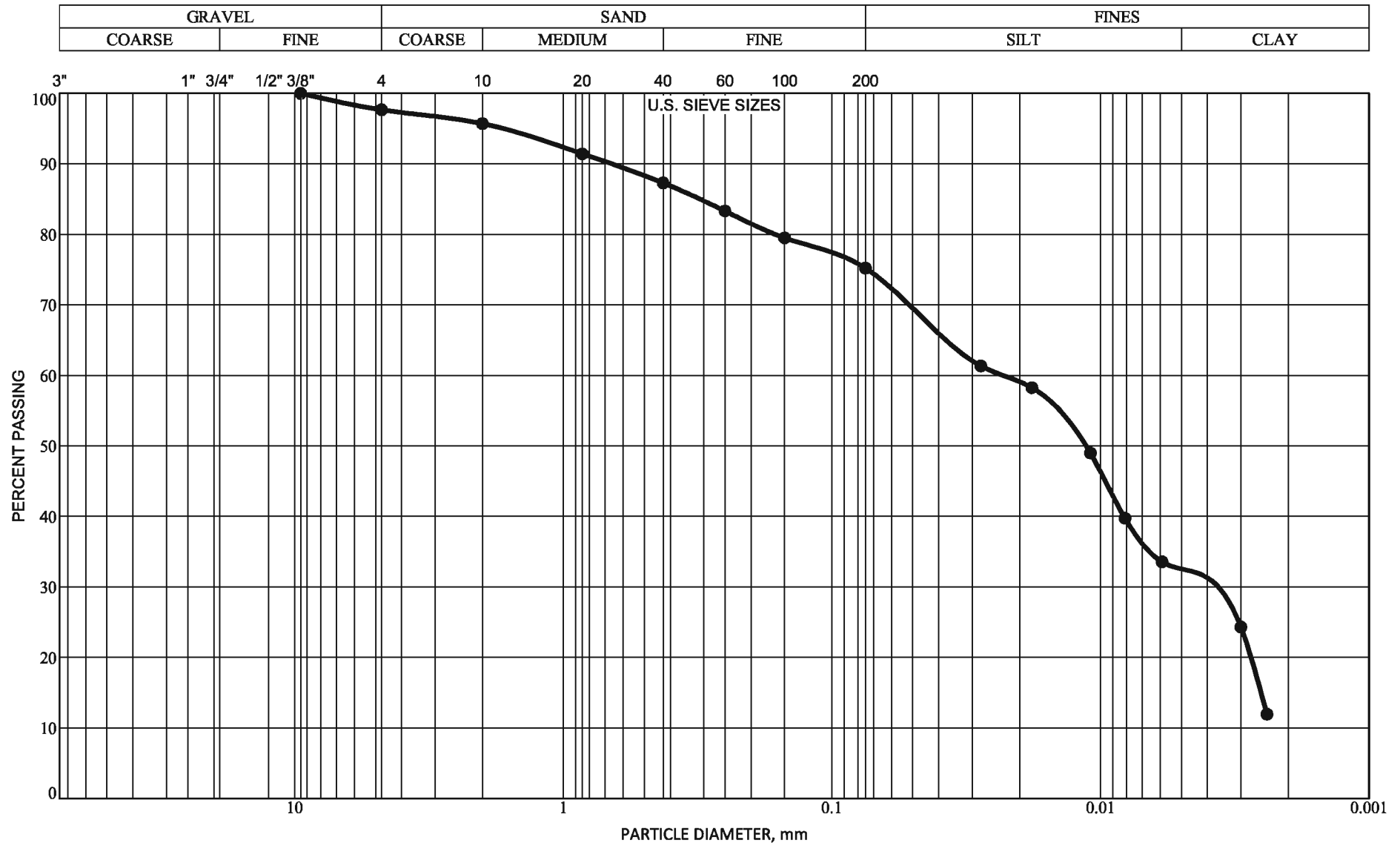


Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-1 DEPTH: 12.5'

GRAVEL	10.2%
SAND	67.7%
SILT	16.7%
CLAY	5.3%
D60=0.515	Cu=28.2
D30=0.116	Cc=1.4
D10=0.018	

CLASSIFICATION:
 SM, Silty Sand w/ a little Gravel

GRAIN SIZE ACCUMULATION CURVE (ASTM)



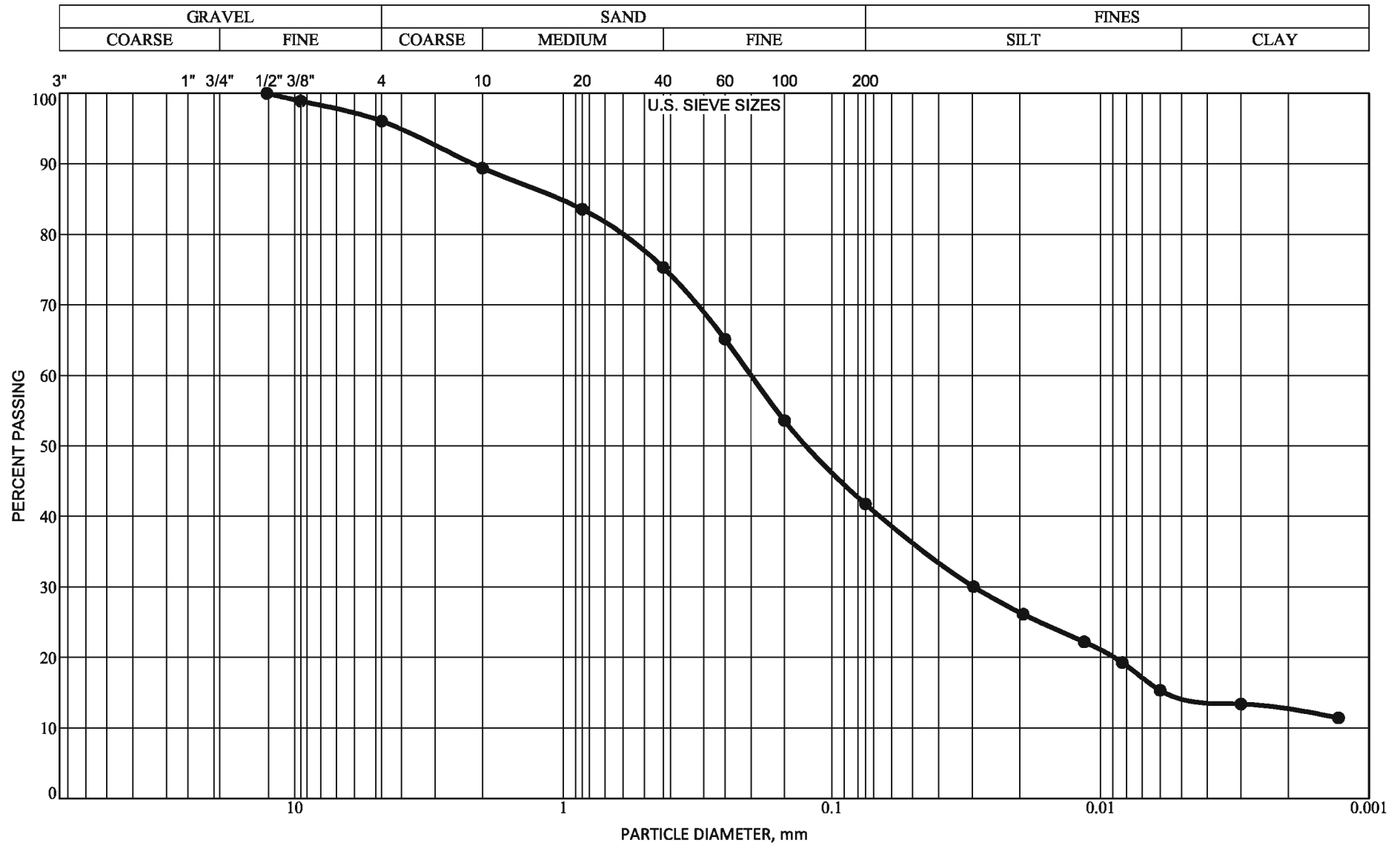
BRAUNSM
INTERTEC

Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-2 DEPTH: 5.0'

GRAVEL	2.3%
SAND	22.5%
SILT	43.9%
CLAY	31.3%
D60=0.023	Cu=
D30=0.005	Cc=
D10=	

CLASSIFICATION:
 CL, Lean Clay w/ Sand

GRAIN SIZE ACCUMULATION CURVE (ASTM)

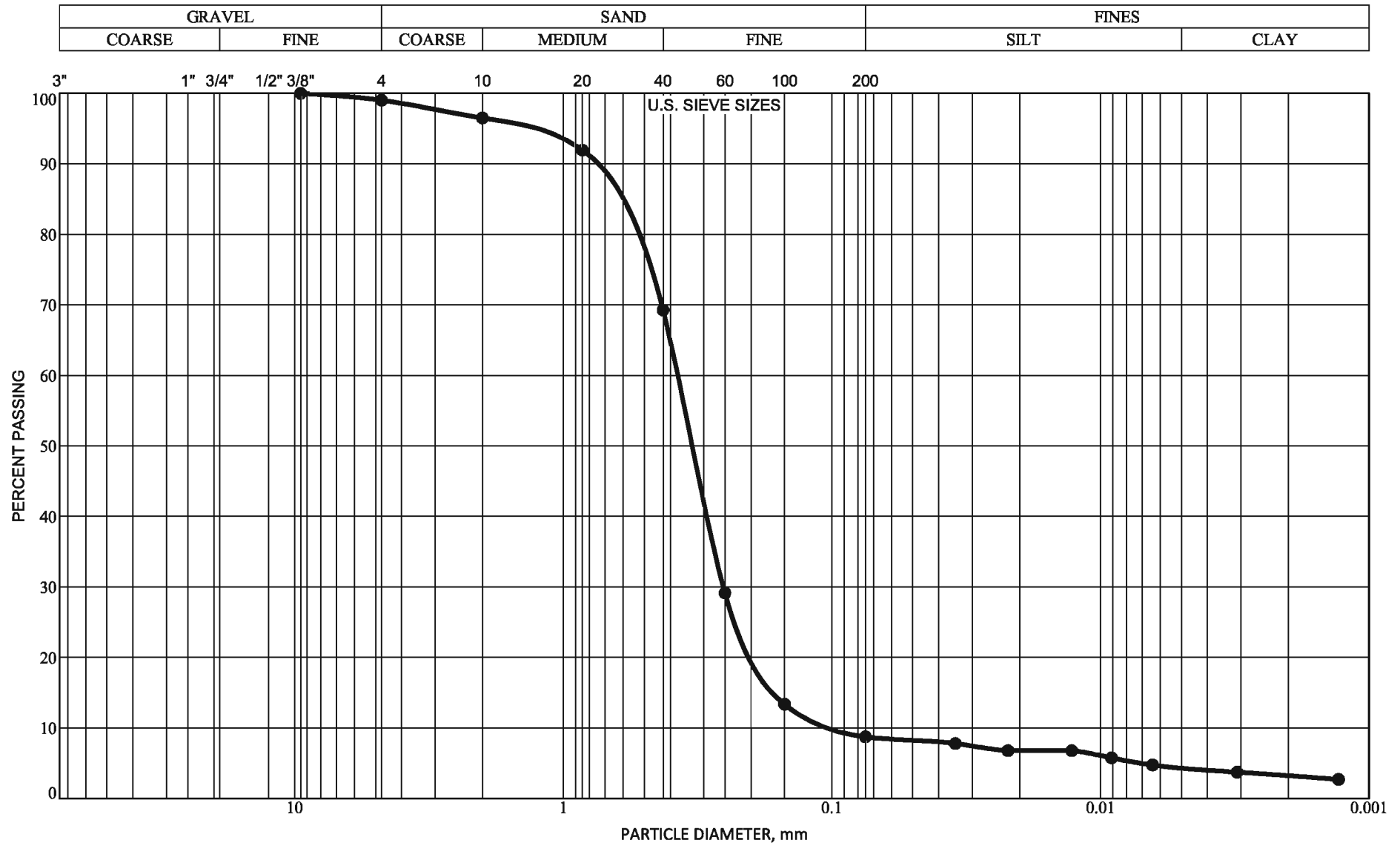


Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-4 DEPTH: 10.0'

GRAVEL	3.9%
SAND	54.3%
SILT	26.9%
CLAY	14.8%
D60=0.199	Cu=
D30=0.030	Cc=
D10=	

CLASSIFICATION:
 SM, Silty Sand w/ traces of Gravel

GRAIN SIZE ACCUMULATION CURVE (ASTM)



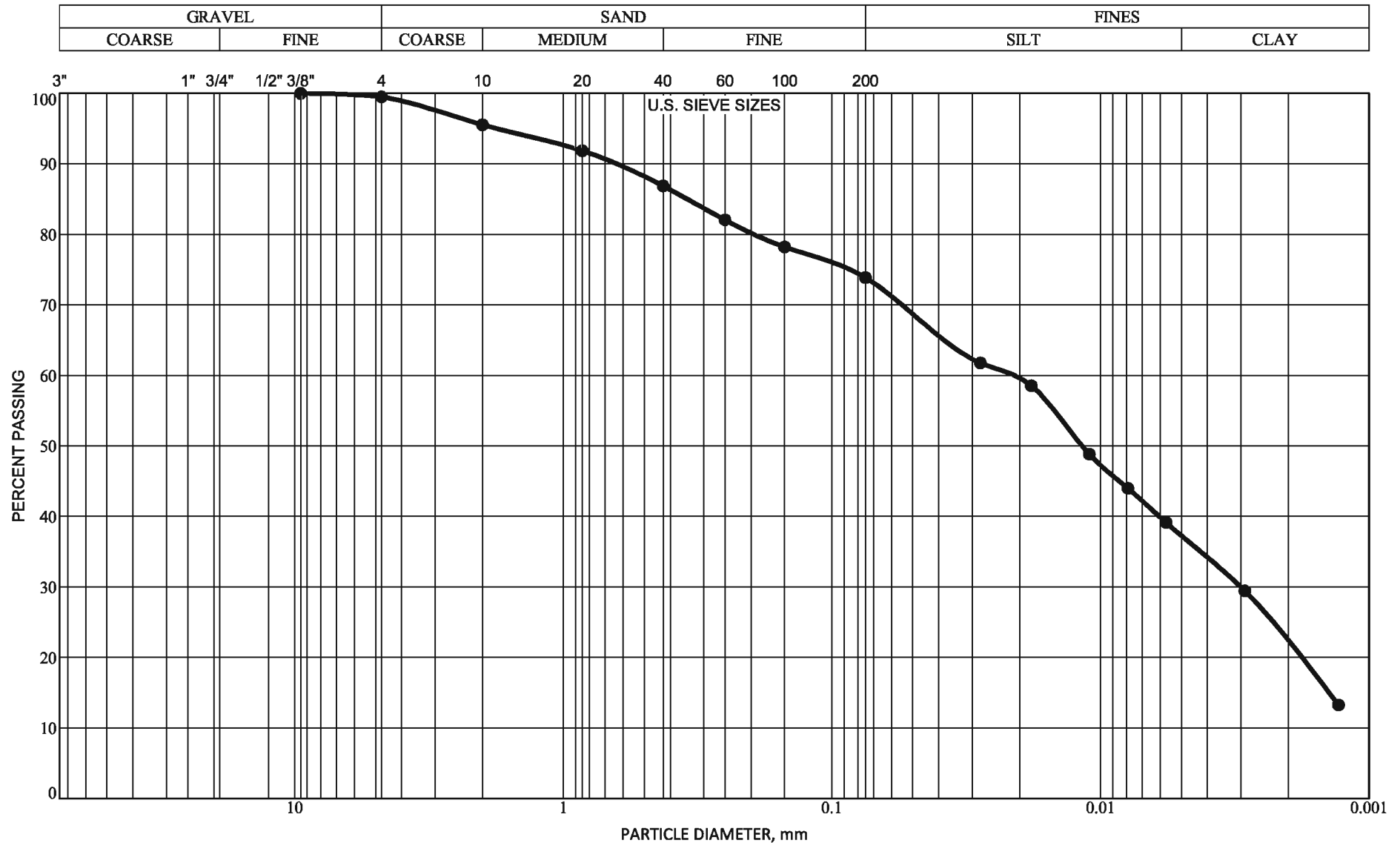
BRAUNSM
INTERTEC

Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-4 DEPTH: 17.5'

GRAVEL	1.0%
SAND	90.3%
SILT	4.3%
CLAY	4.4%
D60=0.376	Cu=4.2
D30=0.253	Cc=1.9
D10=0.090	

CLASSIFICATION:
 SP-SM, Poorly Graded Sand with Silt

GRAIN SIZE ACCUMULATION CURVE (ASTM)



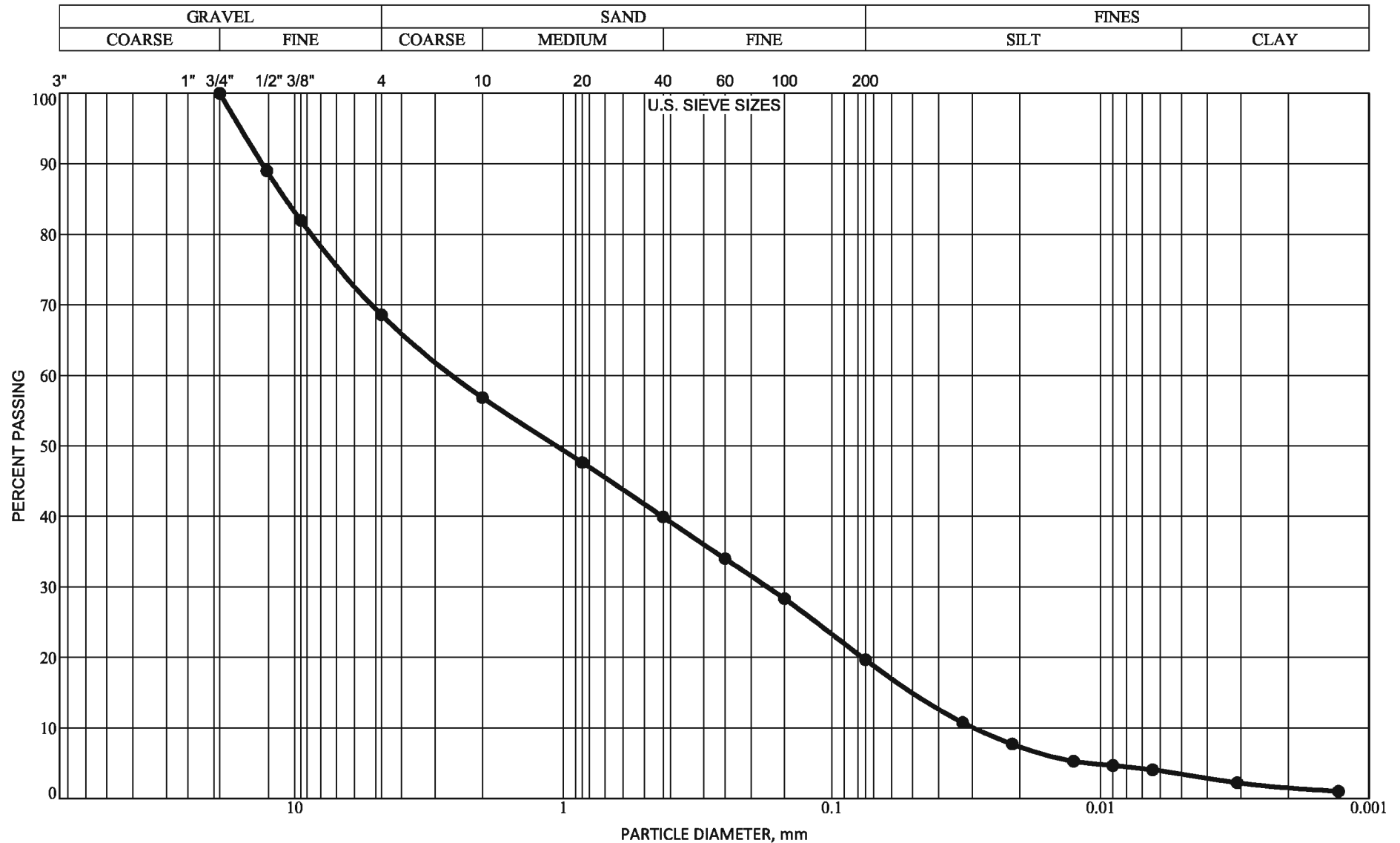
BRAUNSM
INTERTEC

Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-5 DEPTH: 15.0'

GRAVEL	0.5%
SAND	25.6%
SILT	36.6%
CLAY	37.3%
D60=0.022	Cu=
D30=0.003	Cc=
D10=	

CLASSIFICATION:
 CL, Lean Clay w/ Sand

GRAIN SIZE ACCUMULATION CURVE (ASTM)

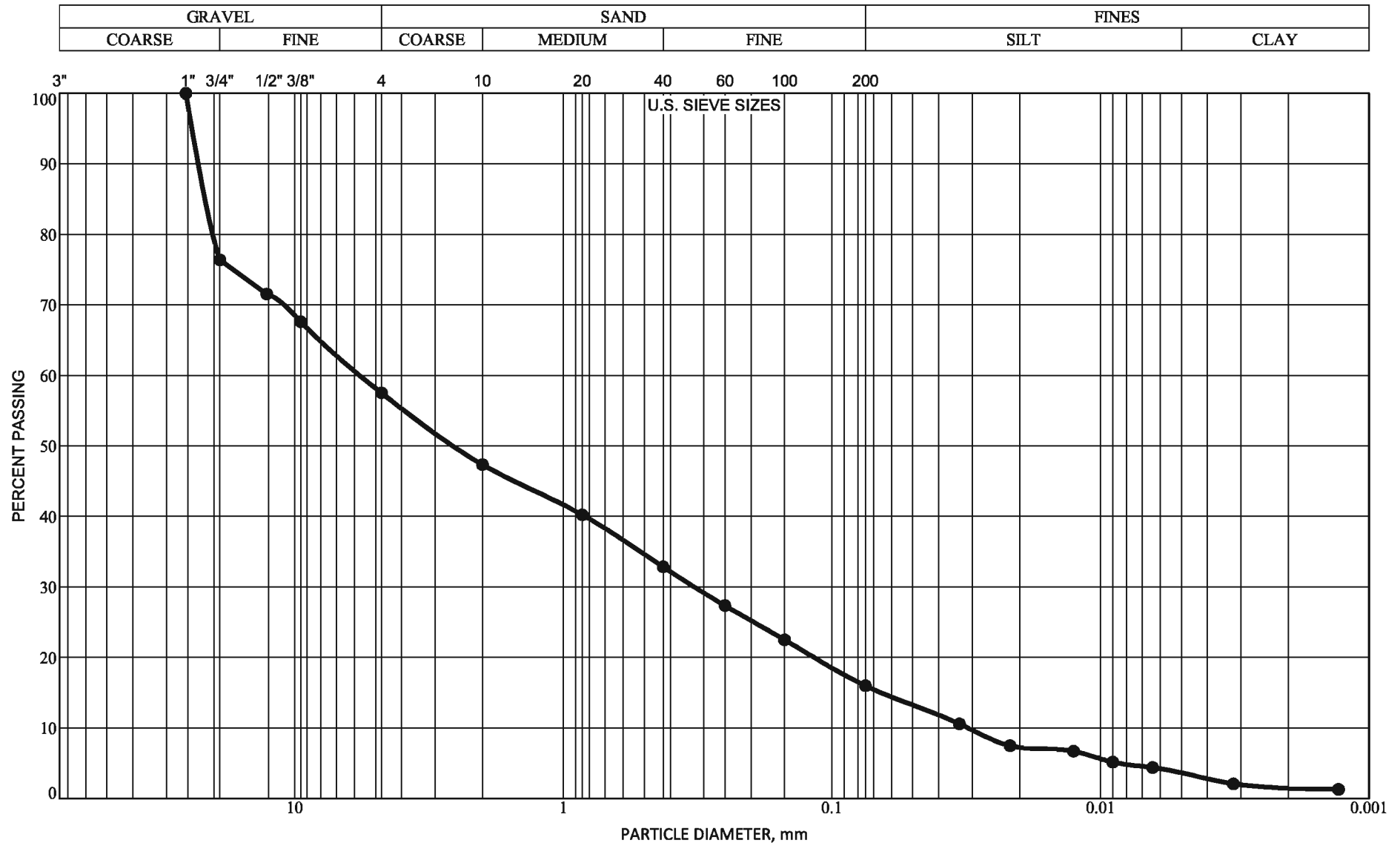


Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-5 DEPTH: 32.5'

GRAVEL	31.4%
SAND	48.9%
SILT	16.2%
CLAY	3.4%
D60=2.521	Cu=86.2
D30=0.174	Cc=0.4
D10=0.029	

CLASSIFICATION:
 SM, Silty Sand w/ Gravel

GRAIN SIZE ACCUMULATION CURVE (ASTM)



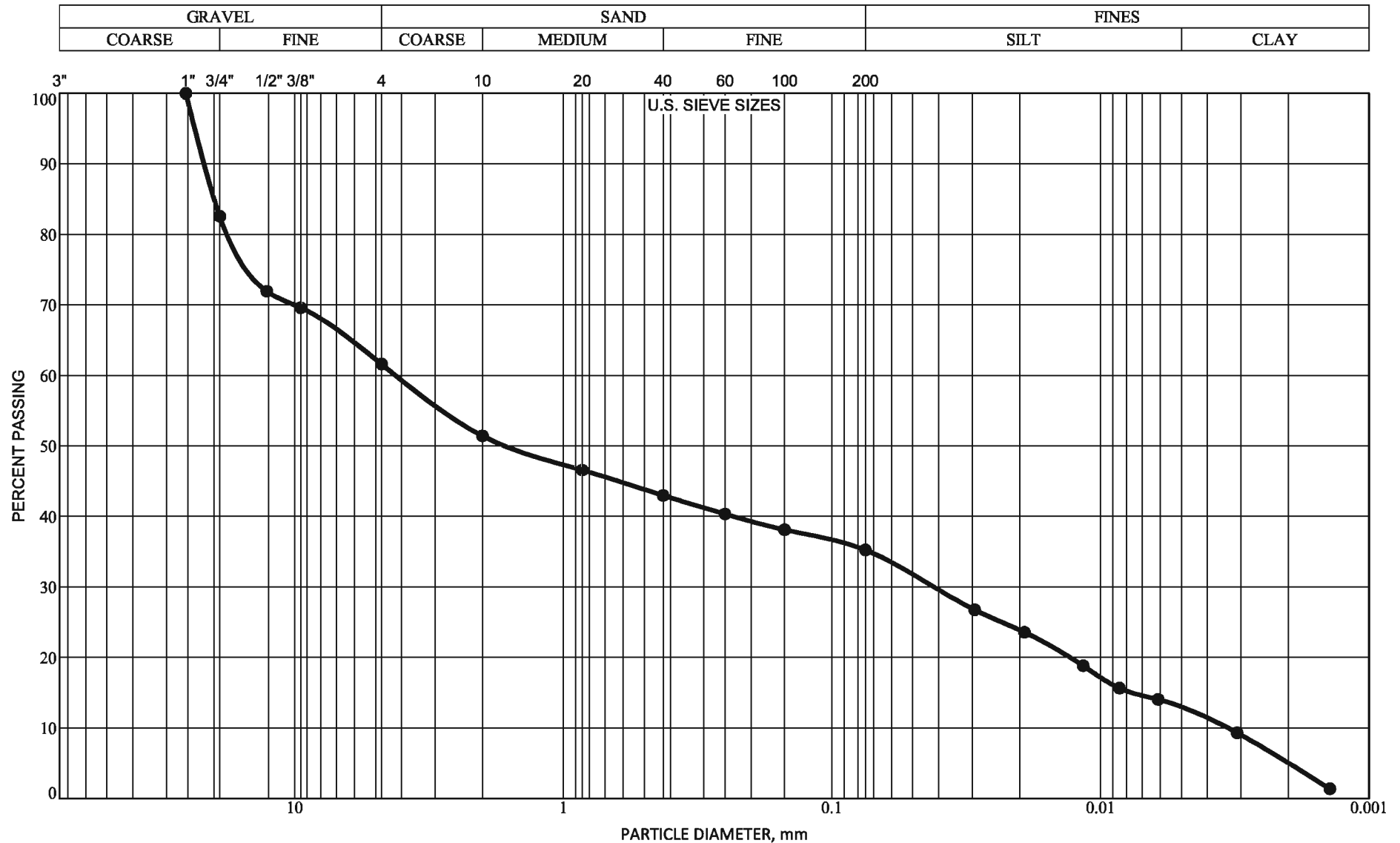
BRAUNSM
INTERTEC

Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-5 DEPTH: 35.0'

GRAVEL	42.5%
SAND	41.5%
SILT	12.4%
CLAY	3.6%
D60=5.627	Cu=182.3
D30=0.322	Cc=0.6
D10=0.031	

CLASSIFICATION:
 SM, Silty Sand w/ Gravel

GRAIN SIZE ACCUMULATION CURVE (ASTM)



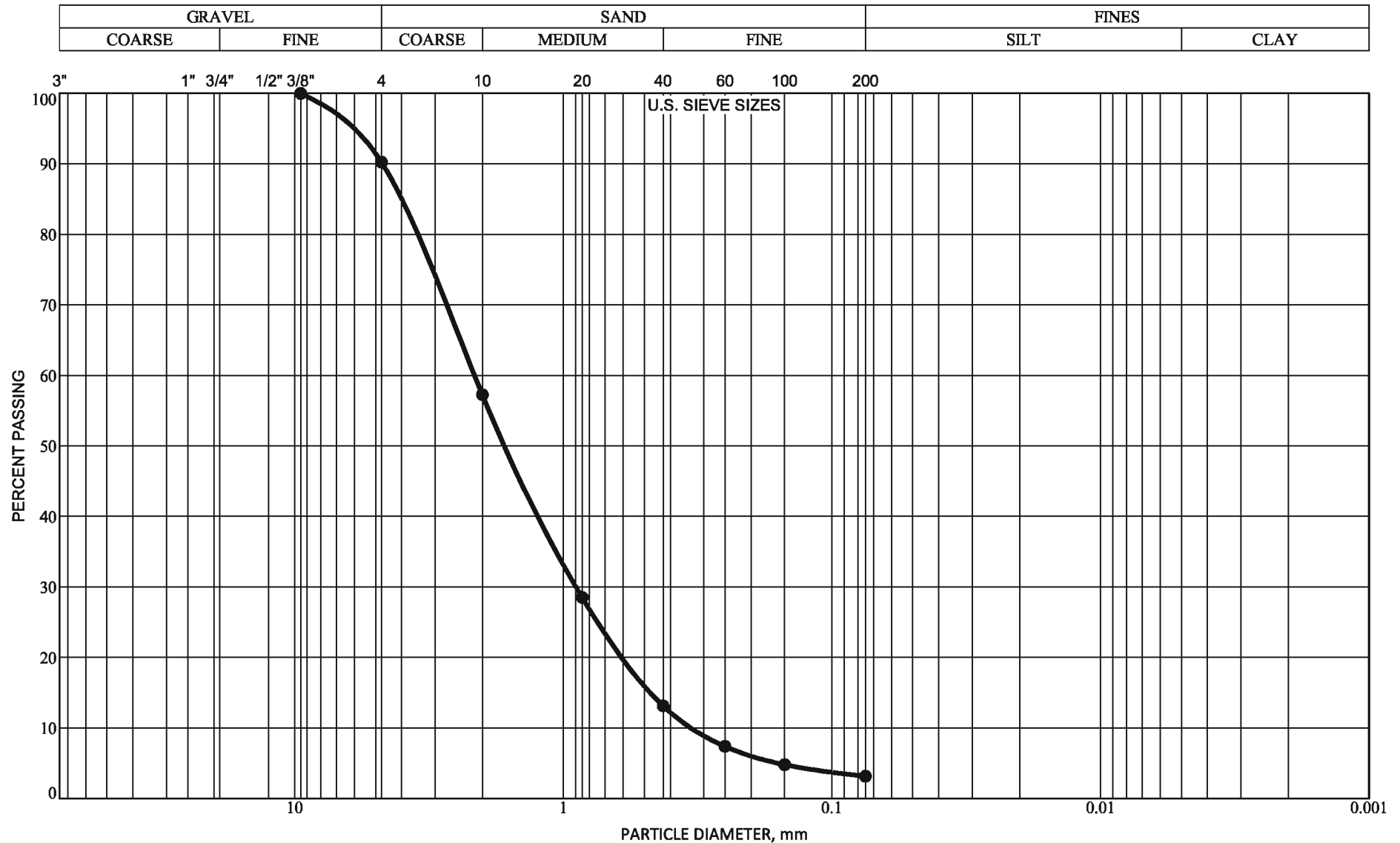
BRAUNSM
INTERTEC

Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-6 DEPTH: 5.0'

GRAVEL	38.4%
SAND	26.4%
SILT	22.6%
CLAY	12.7%
D60=4.139	Cu=1211.5
D30=0.042	Cc=0.1
D10=0.003	

CLASSIFICATION:
 SM, Silty Sand w/ Gravel

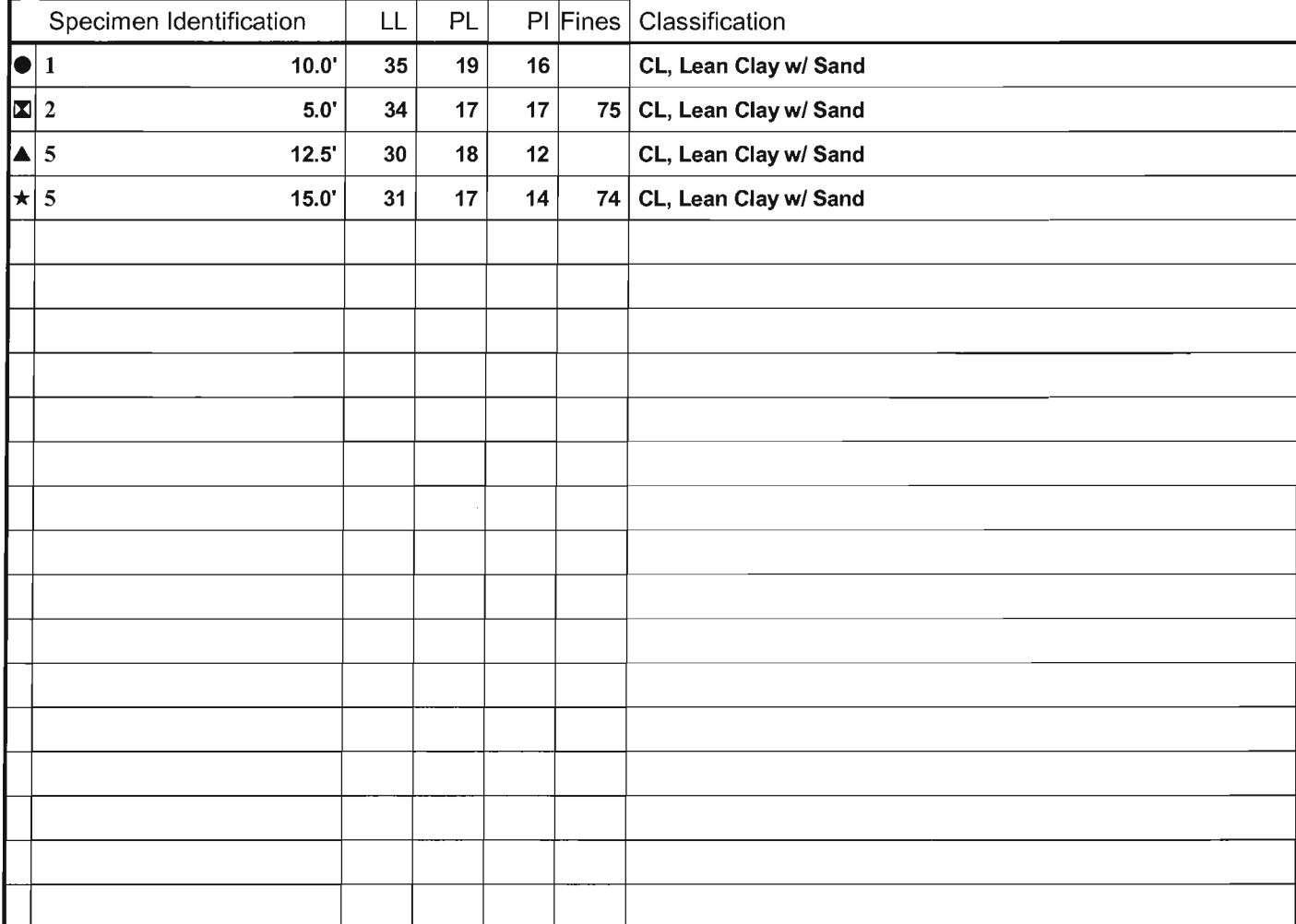
GRAIN SIZE ACCUMULATION CURVE (ASTM)



Braun Project HB-11-06109
Geotechnical Survey
West Side Seep Collection
US Steel MinnTac Tailings Basin
Mountain Iron, Minnesota
 BORING: SB-9 DEPTH: 7.5'

GRAVEL	9.8%
SAND	87.1%
FINES	3.2%
D60=2.148	Cu=6.8
D30=0.888	Cc=1.2
D10=0.318	

CLASSIFICATION:
 SP, Poorly Graded Sand w/ a little Gravel



BRAUN
INTERTEC

**Standard Test Method for Compressive Strength and Elastic Moduli of
Intact Rock Core Specimens under Varying States of Stress and
Temperatures
ASTM D 7012**

Date: October 28, 2011

Project Number: HB-11-06109

Client:

United States Steel Corporation
Mr. Rob Wilmunen
PO Box 417
Mountain Iron, MN 55768

Project Description:

USS - Minnesota Ore Operations
MinnTac West Side Tailings Basin Seep Collection
Mountain Iron, Minnesota

Sample Data

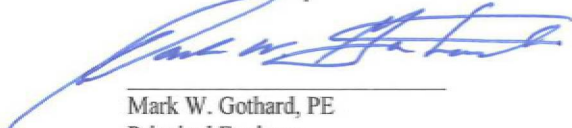
Date Sampled:	10/7/11
Samples Obtained By:	Braun
Sampled From:	Boring ST-2, 13- to 15.5-foot depth
Tested Wet or Dry:	Dry
Sample Preparation:	Cut and Polished

Laboratory Data

Sample Number:	A
Rock Type:	Granite
Diameter (in.):	1.87
Length (in.):	3.67
Length-to-Diameter Ratio (L/D):	1.96
Maximum Load (lbs):	99,910
Area (in ²):	2.75
Compressive Strength (psi):	36,330

Remarks:

Braun Intertec Corporation



Mark W. Gothard, PE
Principal Engineer

November 22, 2011

Project HB-11-06109

Mr. Rob Wilmunen
United States Steel Corporation
PO Box 417
Mountain Iron, MN 55768

Re: Addendum to Geotechnical Survey Report dated November 3, 2011
United States Steel – Minnesota Ore Operations
MinnTac West Side Tailings Basin Seep Collection
Mountain Iron, Minnesota
USS Purchase Order Number 01042800

Dear Mr. Wilmunen:

As requested by Ms. Winnie Chan, Geotechnical Engineer-In-Training from Hatch, Ltd., , on your behalf, we have prepared this Addendum to address questions regarding groundwater observations in our completed soil borings and moisture content tests for SPT samples collected from the soil borings completed for the MinnTac West Side Tailings Basin Seep Collection.

Groundwater

Groundwater observations for the soil borings we completed are summarized below in Table 1.

Table 1. Groundwater Observations Summary

Boring Location	Ground Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
SB-1	TBD	16.5	TBD
SB-2	TBD	14.0	TBD
SB-4	TBD	9.0	TBD
SB-5	TBD	18.5	TBD
SB-7	TBD	19.0	TBD
SB-9	TBD	1.0	TBD

As indicated in Table 1, groundwater was observed at a depth of 14 feet in Boring SB-2 while drilling. This observation differs from the contents of our original survey that indicated groundwater was not encountered while drilling.

The borings excluded from the above table did not encounter groundwater while drilling.

Seasonal and annual fluctuations of both perched and hydrostatic groundwater levels should be anticipated. In particular, elevated levels should be expected following spring thaw and heavy rains. Also, in fine grained, perched levels are common following spring thaw and heavy rains.

Laboratory Testing

As requested by Ms. Chan, we completed moisture content tests on each of the split spoon samples obtained from the soil borings. The results of the moisture content tests are summarized on the attached table.

General

If we can provide additional assistance, please contact Alex Peritz at aperitz@braunintertec.com or Mark Gothard at mgothard@braunintertec.com. We can also be reached in our Hibbing office at 800.828.7313.

Sincerely,

BRAUN INTERTEC CORPORATION



Alex Peritz, EIT
Staff Engineer



Mark W. Gothard, PE
Principal Engineer

Attachments:

Moisture Content Test Result Table

c: Ms. Winnie Chan, Geotechnical Engineer-In-Training
Hatch, Ltd.
Sheridan Science & Technology Park
2800 Speakman Drive
Mississauga, ON
L5K 2R7 Canada

Braun Project: HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				
Borehole	Sample Number	Depth	Moisture Content	Soil Classification
1	35	15	2.7	SM
1A	37	20	8.9	SM
1A	38	22.5	7.8	SM
1A	39	25	7.9	SM
1A	41	30	9.9	SM
1A	42	32.5	11.8	SM
1A	43	35	12.5	SM
1A	44	37.5	10	SM
1A	45	40	6.4	SM
2	53	0	10.9	Topsoil
2	54	2.5	8.5	CL
2	56	7.5	19.9	CL
2	57	10	13.1	CL
2	58	12.5	23.4	SP-SM
2	59	15	0.2	SP-SM
4	1	0	6.5	Tailings
4	3	12.5	12.2	SP-SM
4	4	15	19.1	SP-SM
4	6	20	16.4	SP-SM
4	7	22.5	12.9	SP-SM
4	8	25	10.3	SP-SM
4	9	27.5	5.6	SP-SM
4	10	30	6.8	SP-SM
5	11	0	4.1	Tailings
5	16	20	15.4	SP-SM
5	15	20	12.7	CL
5	17	22.5	19.7	SP-SM
5	18	25	15.5	SP-SM
5	19	27.5	11.9	SP-SM
5	21	30	14.3	SM
5	20	30	7.5	SP-SM
5	24	37.5	4.5	SM
5	29	40	16.2	SM
5	30	42.5	8.9	SM
5	31	45	2.3	SM
5	32	46	1	SM
6	26	0	3.7	Tailings

Braun Project: HB-11-06109 Geotechnical Survey West Side Seep Collection US Steel MinnTac Tailings Basin Mountain Iron, Minnesota				
Borehole	Sample Number	Depth	Moisture Content	Soil Classification
6A	28	7.5	7.5	SM
7	46	15	7.6	SP-SM
7	41	17.5	6.7	SP-SM
7	48	20	6.6	SP-SM
7	49	22.5	8.9	SP-SM
7	50	25	6.9	SP-SM
7	51	27.5	8.7	SP-SM
7	52	30	8.6	SP-SM
9	60	0	4.6	Tailings
9	61	5	13.4	Tailings
9	63	25	10.7	Tailings
9	64	54.5	3.5	SP-SM
9	65	57.5	8.2	SP-SM